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NATIONAL DAM INSPECTION PROGRAM. BROWN CREEK DAM (NDS ID NUMBER--ETC(U)
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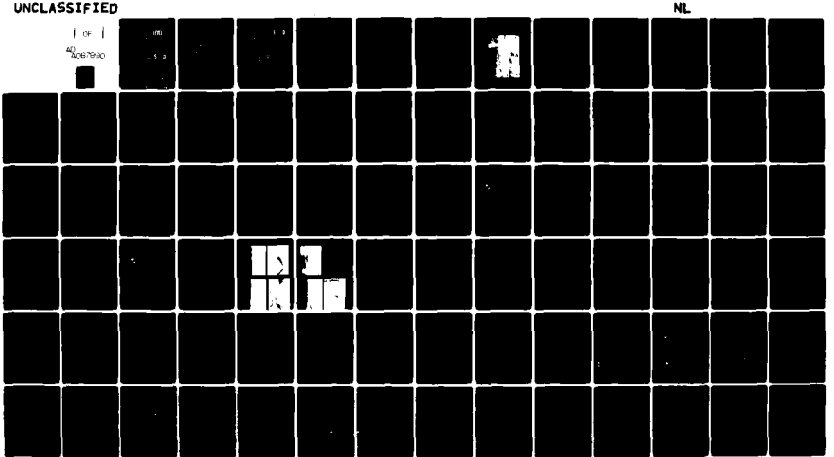

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SUSQUEHANNA RIVER BASIN
BROWN CREEK, LUZERNE COUNTY

PENNSYLVANIA LEVEL II

BROWN CREEK DAM

NDS ID NO. PA-573
DER ID NO. 40-208

BOROUGH OF PLYMOUTH

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

L. ROBERT KIMBALL & ASSOCIATES
DACW31-80-C-0020

Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

JUNE, 1980

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SUSQUEHANNA RIVER BASIN

BROWN CREEK, LUZERNE COUNTY

PENNSYLVANIA

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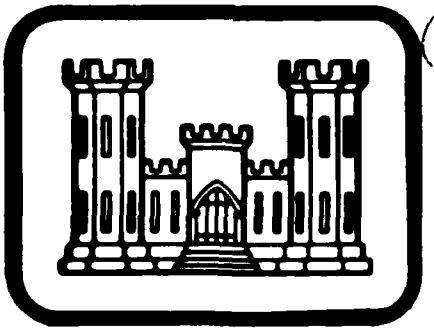

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Brown Creek Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Luzerne
STREAM	Brown Creek
DATE OF INSPECTION	December 11, 1979

ASSESSMENT

The assessment of Brown Creek Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance.

The Brown Creek Dam appears to be in fair condition. The erosion on the crest and downstream embankment in the area of the principal spillway and along the wingwall of the emergency spillway crest should be repaired. Because the reservoir was dry (as is the normal condition) no determination as to potential wet zones or seepage areas could be made. Maintenance of the dam and operating facilities is considered fair.

The Brown Creek Dam is a high hazard-small size dam. The recommended spillway design flood (SDF) for this dam is the 1/2 PMF to PMF. Based on the potential for downstream loss of life, the spillway design flood has been selected as the PMF. The spillway and reservoir are capable of controlling approximately 80% of the PMF without overtopping the embankment (low spot). Based on criteria established by the Corps of Engineers, the spillway is termed inadequate.

The following recommendations and remedial measures should be instituted immediately.

1. Borough officials should be notified as to the possible incorrect operation of the pressure conduit by borough employees during high river stages and the potential hazards associated with such incorrect operation.

2. A more detailed hydraulic and hydrological study should be performed on the 10 foot diameter pressure conduit to better assertain the discharge capability of the conduit assuming both high and low river stages. This study should determine the percent of PMF capability of the dam and principal spillway before emergency spillway flow.

The study should determine adverse affects of spillway flows on the dam.

BROWN CREEK DAM
PA 573

3. The spoil pile blocking the exit channel for the emergency spillway should be cleared and future blockage of the emergency spillway should be discouraged.

4. The erosion on the downstream face of the embankment and crest near the principal spillway structure as well the erosion noted on the embankment and downstream slope near the wingwall of the emergency spillway should be repaired and measures taken to reduce future erosion in these areas.

5. Riprap on the upstream slope is near non-existent and should be repaired if it was included in the original design.

6. The emergency spillway wingwall should be extended beyond the toe of the dam.

7. A cover should be placed on top of the low flow inlet structure.

8. Regular safety inspections should be conducted in accordance with provisions stipulated by the Commonwealth of Pennsylvania regarding the inspections of dams.

9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam. Large spillway discharges could possibly result in the loss of life and heavy property damage and should be treated accordingly in the warning and evacuation plan.

SUBMITTED BY:

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

Date

R. Jeffrey Kimball, P.E.

APPROVED BY:

17 July 80
Date

Overview of upstream slope and overflow spillway - Brown Creek Dam.

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APPENDICES

PHASE I
NATIONAL DAM INSPECTION PROGRAM
BROWN CREEK DAM
NDI. I.D. NO. PA 573
DER I.D. NO. 40-208

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Brown Creek Dam is an earthfill dam, 920 feet long and 20 feet high. The crest width of the dam is 8 feet. Both the upstream slope and downstream slopes are 2H:1V. The embankment is L shaped and the upstream slope is protected with riprap to 8 feet below the embankment crest.

The principal spillway is located at the elbow of the embankment and consists of an ogee shaped concrete weir with a crest length of 53 feet. The spillway exit channel is formed by a 10 foot diameter concrete conduit which eventually discharges into the Susquehanna River. The length of the conduit is approximately 1,900 feet. The emergency spillway is located at the left abutment and consists of a concrete weir with a crest length of 102 feet.

In 1966, modifications were made at the intake structure of the debris dam. The modifications consisted of construction of a slotted reinforced concrete box structure located on the upstream side of the existing concrete spillway section leading to the pressure conduit. A 24" diameter steel pipe extends from the intake box through the existing ogee spillway. The pipe is 13 feet in length and is set with cement grout, the pipe will discharge low flows into the pressure conduit.

b. Location. The dam is located on Brown Creek, North of the intersection of Edward and Willow Streets, Plymouth Borough, Luzerne County, Pennsylvania. Brown Creek Dam can be located on the Wilkes-Barre West, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Brown Creek Debris Dam is a small size dam (20 feet high, 28 acre-feet).

d. Hazard Classification. Brown Creek Debris Dam is a high hazard dam. Downstream conditions indicate that loss of more than a few lives is probable should the structure fail. The Borough of Plymouth is located immediately downstream of the debris dam. Approximately 100 homes (500 people) are located downstream of Brown Creek Dam.

e. Ownership. Brown Creek Debris Dam is owned by the Borough of Plymouth. Correspondence should be addressed to:

Mayor Frank Burns
Borough of Plymouth
Borough Building
Plymouth, PA 18651
(717) 779-9538

f. Purpose of Dam. Brown Creek Debris Dam was constructed on Brown Creek for the purpose of collecting debris during periods of heavy rainfall.

g. Design and Construction History. Brown Creek Debris Dam was designed by Bourquard, Geil and Mathews, Consulting Hydrologic Engineers, 1822 North Second Street, Harrisburg, PA. The dam was built around 1958 for the Department of Forest and Waters Division of Flood Control and turned over to the Borough of Plymouth. Very little information is available on the construction history of the dam. Original design drawings which include the 1966 modification to the principal spillway (low flow inlet) were reviewed for the purpose of this report.

h. Normal Operating Procedures. The dam is currently used for the purpose of debris collection on Brown Creek, no regularly scheduled operations are conducted at the dam. Debris which collects in the reservoir is cleared on an as-needed basis. Normally, no water is impounded in the reservoir.

1.3 Pertinent Data.

a. Drainage Area. 2.64 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site	Unknown
Total design discharge	5000
Design discharge - outlet works	2100
Design discharge - emergency spillway	2900
Combined discharge capacity at top of dam	3750
Principal spillway capacity at top of dam	2285
Emergency spillway capacity at top of dam	1465

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on principal spillway crest elevation 560.0 feet from original design drawings.

Top of dam - low spot	566.1
Top of dam - design height	568.0
Maximum pool - design surcharge	567.3
Full flood control pool	566.1
Normal pool	None (empty)
Principal spillway crest	560.0
Emergency spillway crest	563.7
Low inflow invert	552.7
Exit invert at river	517.4
Streambed at centerline of dam	550
Maximum tailwater	None
Toe of dam	546.0

d. Reservoir (feet).

Length of maximum pool	450
Length of normal pool	0

e. Storage (acre-feet).

Normal pool	0
Top of dam	28

f. Reservoir Surface (acres).

Top of dam	3.5
Principal spillway crest	3.0
Emergency spillway crest	3.2

g. Dam.

Type	Earth embankment
Length	920 feet
Embankment height	20 feet
Structural Height	30 feet
Top width	8 feet
Side slopes - upstream	2H:1V
- downstream	2H:1V
Zoning	None
Impervious core	None
Cutoff	None
Grout curtain	None

h. Reservoir Drain (Principal spillway).

Type	10' diameter concrete conduit with concrete ogee weir
Length	Approximately 1900 feet
Closure	Stop logs at discharge point
Access	At discharge or spillway
Regulating facilities	None

i. Emergency spillway.

Type (emergency spillway)	Concrete weir
Length (concrete weir)	102 feet
Length at elevation 563.7	118 feet
Crest elevation	563.7
Upstream channel	Lake
Downstream channel	Legislative route through Plymouth Borough

SECTION 2
ENGINEERING DATA

2.1 Design. The owner did not provide any design data. The Commonwealth of Pennsylvania, Department of Environmental Resources supplied some back-up data pertaining to general statistics of the dam, several drawings were available to include the 1966 modification drawings relative to the low flow inlet drawings and details. Photographs, permits and correspondence were also supplied by PennDER. All information contained in the PennDER files were reviewed to complete this report.

2.2 Construction. No information exists on construction of the dam.

2.3 Operation. No operating records are maintained.

2.4 Evaluation.

a. Availability. Engineering data were provided by PennDER, Bureau of Dams and Waterways Management and through interviews with the owner. A representative of the Borough of Plymouth was interviewed to obtain data of operation and maintenance of the dam. An employee of the Borough, Mr. Bob Ricko, accompanied the inspection team.

b. Adequacy. Detailed analyses cannot be made because of a lack of detailed construction information. This Phase I Report is based upon available data, visual observation, and a hydrologic and hydraulic analysis. Sufficient information is available to complete the Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Brown Creek Debris Dam was conducted by personnel of L. Robert Kimball and Associates on December 19, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to be in fair condition. From a brief survey conducted during the inspection, it was noted that a low spot exists near the principal spillway structure adjacent to a wingwall on the embankment crest. In general, the crest of the dam rises from the right abutment. Both the upstream and downstream slopes were measured to be 2H:1V. The upstream slope is protected with riprap to a distance approximately 8 feet from the embankment crest. It was observed during the inspection that the riprap on the upstream slope is very minimal. The upstream and downstream slope as well as the embankment crest are covered with grass.

Some erosion was noted near the elbow of the embankment sections on the downstream slope of the dam and near the wingwall of the emergency spillway at the left abutment.

The earthen embankment is L shaped with the principal spillway located at the elbow of the embankment. The crest width was measured to be 10 feet. At the time of inspection the reservoir was dry and remains in that condition until such a time as heavy rainfall causes runoff to be collected in the debris dam and eventually discharged through the low flow inlet of the principal spillway structure. Because of the dry reservoir no seepage or wet zones were noted.

The debris dam is located on the edge of the Borough of Plymouth. The immediate downstream exposure of the dam is the Borough of Plymouth, several trailers are located at the downstream toe of the left embankment arm and in the emergency spillway discharge channel.

c. Appurtenant Structures. The principal spillway is located at the elbow of the embankment and consists of a concrete ogee shaped weir. The weir appeared to be in good

condition. The wingwalls constructed at either side of the concrete weir were also observed to be in good condition. A 4 x 4 foot low flow box inlet is located on the upstream face of the ogee crest and discharges flow through a 24" diameter steel pipe, 13 feet in length. The 24" diameter pipe passes through the ogee section and discharges into a 10 foot diameter concrete conduit as does discharge over the ogee spillway. The 10 foot diameter concrete conduit runs under the Borough of Plymouth for a distance of approximately 1900 feet and eventually discharges at the Susquehanna River. It was reported by Mr. Bob Ricko (a borough employee who attended the inspection) that during periods of high stages in the river, water from the river begins to back up into the 10 foot diameter concrete conduit. It was also reported by Mr. Ricko that the outlet structure for the 10 foot diameter concrete conduit is supplied with steel beam stop logs for the purpose of preventing the Susquehanna River from backing up into the conduit.

The conduit is designed to discharge flow into the river and if in fact the outlet is blocked as a standard operational procedure during high river stages the conduit will not serve its design function.

d. Reservoir Area. The watershed is covered with almost equal areas of woodlands and strip mines. A high mine refuse pile is located at the headwaters of the reservoir but did not appear to be susceptible to landslides which would affect the storage volume of the reservoir or overtopping of the dam by displacing water, during periods of reservoir storage.

e. Downstream Channel. There is no defined natural downstream channel below the Brown Creek Debris Dam. Discharge through the principal spillway is carried through a 10 foot diameter concrete conduit. Discharge through the emergency spillway would flow along a legislative route through the Borough of Plymounth and parallel to the left arm of the embankment.

3.2 Evaluation. In general, the embankment and appurtenant structures appear to be in fair condition. The capability of the 10 foot diameter concrete conduit to discharge flows through the principal spillway during periods of high river stages is questionable because borough employee's set the steel stop logs into a position which blocks the conduit thus rendering it useless to serve its design function. The borough should be questioned as to the validity of this procedure and notified as to the negative effect it produces relative to safe operation of the dam during periods of heavy rainfall.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained in a drained condition. Water is stored in the reservoir during periods of high inflow, eventually discharging through the low flow inlet at the principal spillway structure. It was reported by Mr. Bob Ricko (a borough employee who attended the inspection) that during periods of high stages in the river, water from the river begins to back up into the 10 foot diameter concrete conduit and that the stop logs are set in position to prevent the river water from entering the conduit.

4.2 Maintenance of the Dam. No planned maintenance schedule exists. Maintenance of the dam is performed by the Borough of Plymouth on an as-needed basis. Maintenance of the dam is considered fair.

4.3 Maintenance of Operating Facilities. Maintenance of the spillway and outlet conduit is considered fair. Debris is cleared from the reservoir and principal spillway on an as-needed basis by Borough employees.

4.4 Warning System in Effect. There is no warning system in effect to warn downstream residents of large spillway discharges or imminent failure of the dam.

4.5 Evaluation. Maintenance of the dam and operating facilities is considered fair. There is no system in effect to warn downstream residents of large spillway discharges or imminent failure of the dam. Borough officials should be notified as to possible hazards associated with incorrect operation of the 10 foot diameter pressure conduit outlet structure.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to hydrology or hydraulics were available.

b. Experience Data. No rainfall, runoff or reservoir level data were available. The spillway reportedly has functioned adequately in the past.

c. Visual Observations. The principal and emergency spillway appeared to be in good condition with the exception of the spoil pile which partially blocks the discharge channel of the emergency spillway near the left abutment.

A low spot was noted on the embankment near the principal spillway structure and adjacent to a wingwall on the embankment crest.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. Discharge through the principal spillway was considered in this analysis. Because of questionable operating procedures (see Section 4.1) it should be noted that this analysis is valid only if the 10' diameter pressure conduit is allowed to serve its design function.

2. Pool elevation in the reservoir prior to the storm is at the principal spillway crest elevation 560.0.

3. The top of dam was considered the low spot elevation 566.1. Variation of the embankment crest elevations were investigated through the $L, $V program option.

4. The spoil pile of ashes in the spillway channel was not considered because of the erosive nature of the material.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	4732 cfs
Combined spillway capacity	3750 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) is based on the hazard and size classification of the dam. The recommended spillway design flood (SDF) for this dam is the 1/2 PMF to PMF. Based on the potential for downstream loss of life and property damage, the SDF has been selected as the PMF. Based on the following definition provided by the Corps of Engineers, the spillway is rated as inadequate as a result of our hydrologic analysis.

Inadequate - All high hazard dams which do not pass the SDF (PMF).

The spillway and reservoir are capable of controlling approximately 80% of the PMF without overtopping the embankment (low spot).

5.4 Summary of Dam Breach Analysis. As the subject dam can satisfactorily pass 50% of the PMF (based on our analyses) it was not necessary to perform the dam breach analysis and downstream routing of the flood wave.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. No visible signs of potential instability were observed during the inspection. The reservoir was in the drained condition as is its normal case except during periods of heavy rainfall. The embankment slopes are grass covered. There is riprap protection on the upstream face of the embankment beginning approximately 8 feet below the embankment crest. Riprap on the upstream slope was minimal. Due to the fact that the reservoir was dry, identifying potential seepage areas was not possible.

b. Design and Construction Data. No stability analyses are on record for this dam. Design drawings were available for review by the inspection team. No construction data is available.

c. Operating Records. No operating records are maintained.

d. Post Construction Changes. In 1966 the principal spillway was modified to include a low flow inlet.

e. Seismic Stability. Based on conditions observed during the inspection the dam appears to be stable. The dam is located in Seismic Zone 1. No seismic stability analyses has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in fair condition. The reservoir was in a drained condition as is the normal case, except during periods of heavy rainfall when the reservoir serves the purpose to collect debris. Some erosion was noted on the downstream slope near the principal spillway structure as well as on the crest and downstream slope adjacent to a wingwall of the emergency spillway near the left abutment (see Appendix A-13).

The visual observations, review of available information, hydrologic and hydraulic calculations indicate that the Brown Creek Debris Dam's spillway is inadequate. The spillway is capable of controlling approximately 80% of the PMF without overtopping the embankment (low spot). If a PMF event were to occur, some homes located in the emergency spillway discharge channel would be flooded.

b. Adequacy of Information. Detailed analyses cannot be made of the embankment because of the lack of any construction data. Design drawings were available and were reviewed for the purpose of this report. Based on conditions observed during the inspection the embankment appeared to be stable. This Phase I Report is based on visual observations, review of avaliable data, hydrologic and hydraulic calculations, and past operations and performance.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. Borough officials should be notified as to the possible incorrect operation of the pressure conduit by borough employees during high river stages and the potential hazards associated with such incorrect operation.

2. A more detailed hydraulic and hydrological study should be performed on the 10 foot diameter pressure conduit to better assertain the discharge capability of the conduit assuming both high and low river stages. This study should determine the percent of PMF capability of the dam and principal spillway before emergency spillway flow.

The study should determine adverse affects of spillway flows on the dam.

3. The spoil pile blocking the exit channel for the emergency spillway should be cleared and future blockage of the emergency spillway should be discouraged.

4. The erosion on the downstream face of the embankment and crest near the principal spillway structure as well the erosion noted on the embankment and downstream slope near the wingwall of the emergency spillway should be repaired and measures taken to reduce future erosion in these areas.

5. Riprap on the upstream slope is near non-existent and should be repaired if it was included in the original design.

6. The emergency spillway wingwall should be extended beyond the toe of the dam.

7. A cover should be placed on top of the low flow inlet structure.

8. Regular safety inspections should be conducted in accordance with provisions stipulated by the Commonwealth of Pennsylvania regarding the inspections of dams.

9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam. Large spillway discharges could possibly result in the loss of life and heavy property damage and should be treated accordingly in the warning and evacuation plan.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Brown Creek Debris Dam COUNTY Luzerne STATE Pennsylvania ID# PA 573

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION December 11, 1979 WEATHER Clear and warm TEMPERATURE 60°

POOL ELEVATION AT TIME OF INSPECTION None M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

O.T. McConnell RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Crest of dam and downstream slopes show some erosion.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment appears to be good. Low spot on crest near principal spillway structure - See page A-12.	
RIPRAP FAILURES	Only minimal riprap on upstream slope. Riprap needs to be repaired in several locations.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Crest and slopes grass covered.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Some erosion on crest near principal spillway structure and near concrete wingwall at emergency spillway. Wingwall of emergency spillway should be extended beyond toe of dam.	
ANY NOTICEABLE SEEPAGE	Reservoir was dry. Possible detection of seepage zones or wet areas could not be made.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None.	
INTAKE STRUCTURE	Observed during inspection.	
OUTLET STRUCTURE	Observed during inspection.	
OUTLET CHANNEL	Unobserved during inspection.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete appears to be in good condition. Wingwall should be extended beyond toe.	
APPROACH CHANNEL	Lake.	
DISCHARGE CHANNEL	10' diameter concrete conduit. Length of conduit approximately 1900 feet. Discharge structure at Susquehanna River.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

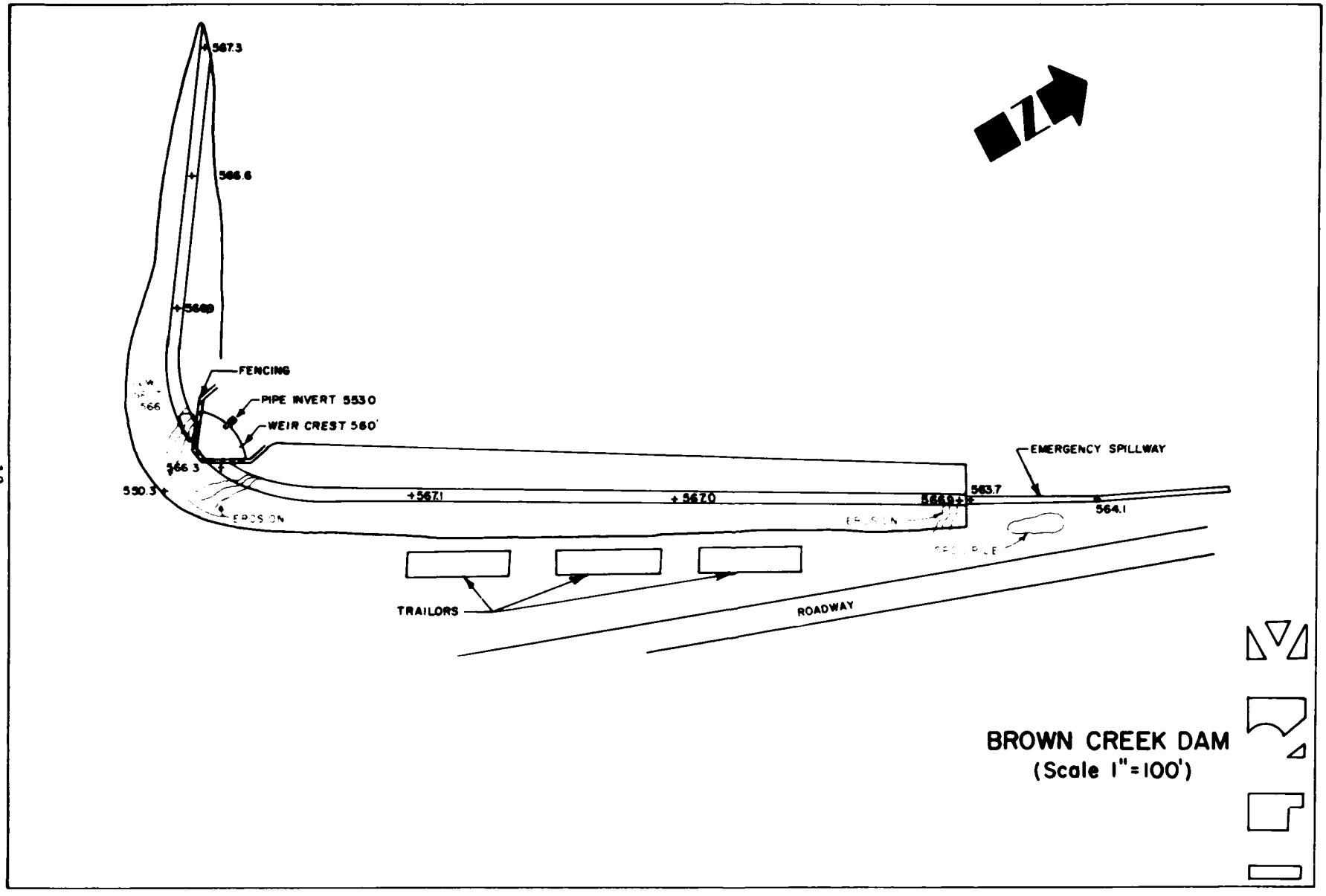
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	10 foot diameter concrete conduit. Unobserved during inspection.	
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Borough of Plymouth immediately downstream of dam. Approximately 100 homes - 500 people.	

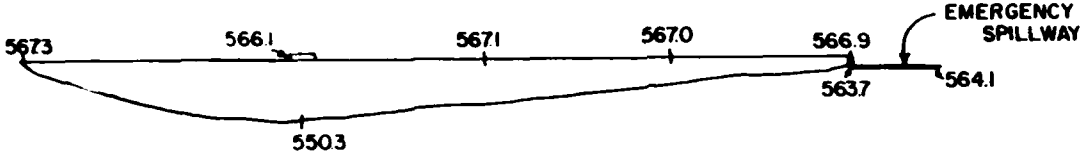
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep but appear to be stable.	
SEDIMENTATION	None.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	


567.3
566.6
FENCING
PIPE INVERT 553.0
WEIR CREST 560'
566.3
550.3
+567.1
+567.0
563.7
564.1
EMERGENCY SPILLWAY
EROSION
TRAILORS
ROADWAY
BROWN CREEK DAM
(Scale 1"=100')



PROFILE
LOOKING UPSTREAM

Scale: Hor. = 1" = 200'
Vert. = 1" = 50'

BROWN CREEK DAM

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Brown Creek Debris Dam

ID# PA 573

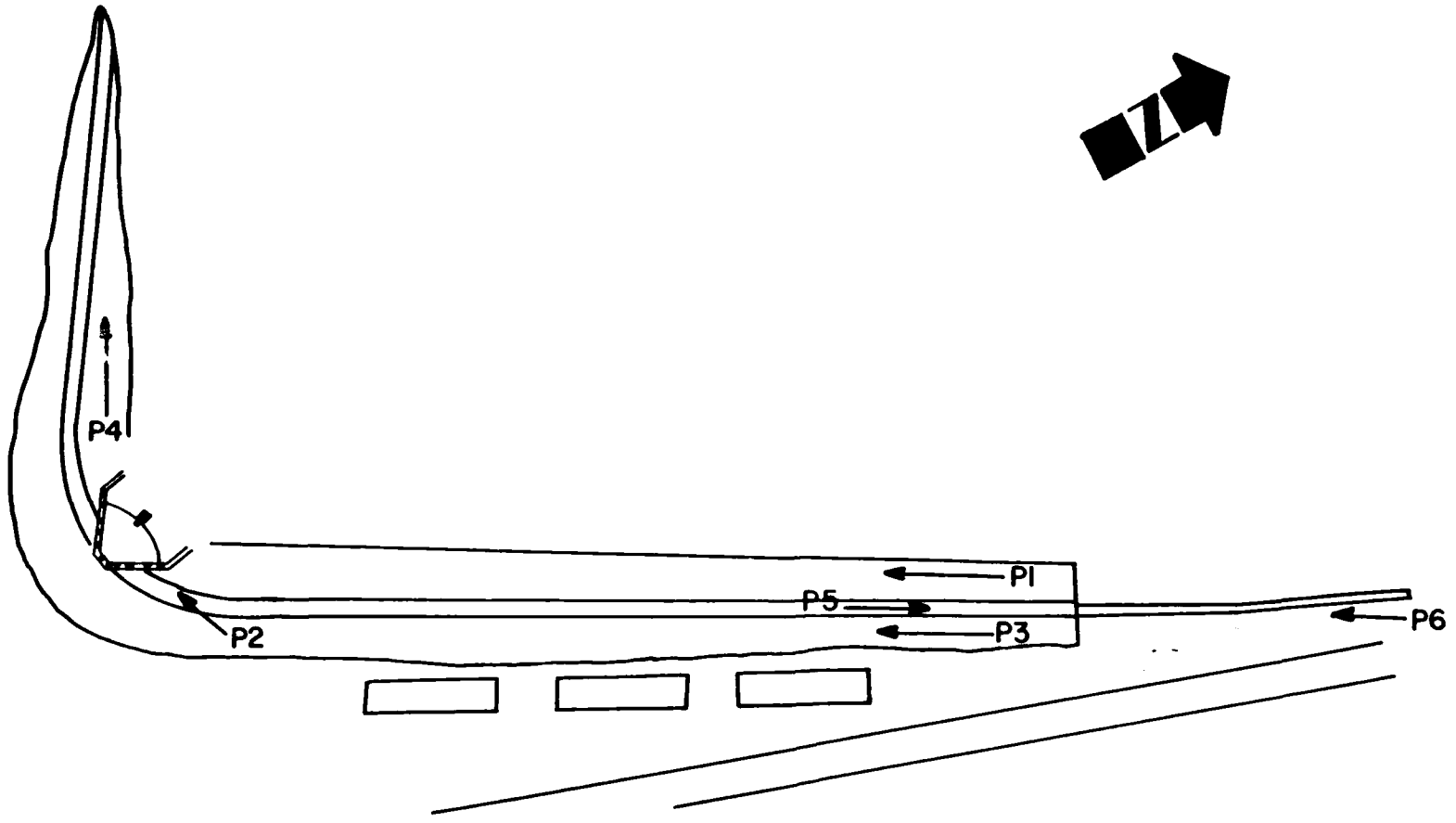
ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. 7.5 minute quadrangle.
CONSTRUCTION HISTORY	None.
TYPICAL SECTIONS OF DAM	None.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	None. None. None. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Unknown.
POST-CONSTRUCTION SURVEYS OF DAM	Unknown.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	1966 modifications of principal structure to include a low flow inlet structure.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Construction drawings in PennDER files.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS



P— INDICATES PHOTO LOCATION

PHOTO INDEX
BROWN CREEK DAM
SCALE 1" = 100'

C-1

BROWN CREEK DEBRIS DAM

Photograph Descriptions

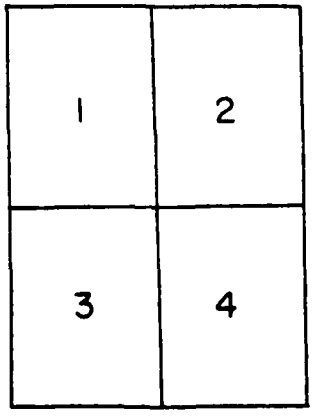
Sheet 1. Front

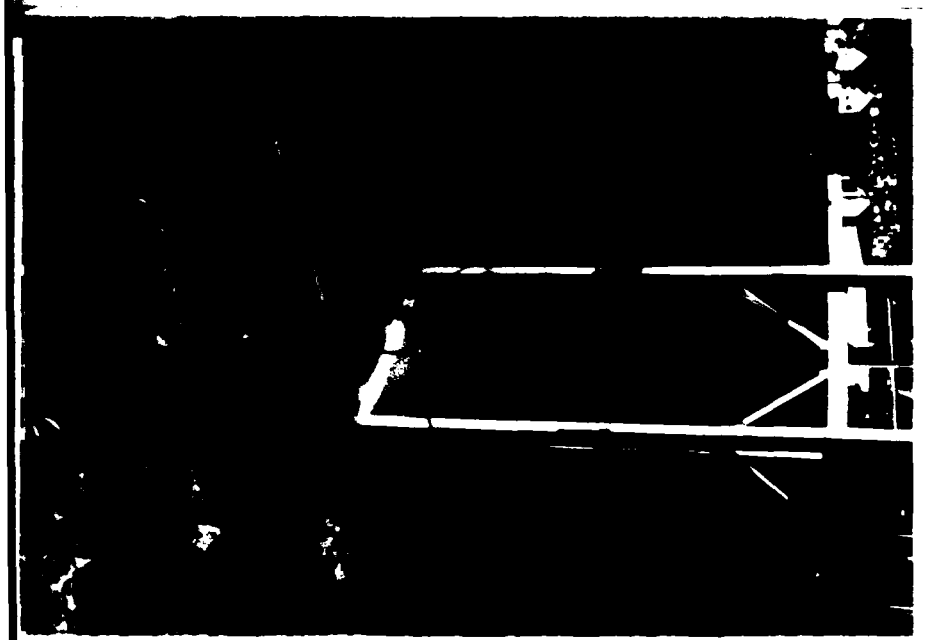
(1) Upper left - Upstream slope of dam.
(2) Upper right - Overflow spillway and low level intake.
(3) Lower left - Downstream slope and exposure of left embankment.
(4) Lower right - Upstream slope and right abutment.

Sheet 1. Back

(5) Upper left - Spillway blockage and upstream slope of dam.
(6) Lower left - Left abutment and spillway. Note blockage of spillway.
(7) Lower right - Discharge end of overflow spillway conduit at Susquehanna River.

TOP OF PAGE





APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 40" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Brown Creek Debris Dam

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 (0.98) = 21.76 inches

STATION	1	2	3
Station Description	Brown Creek Debris Dam		
Drainage Area (square miles)	2.64		
Cumulative Drainage Area (square miles)	2.64		
Adjustment of PMF for Drainage Area (%)[1]			
6 hours	117		
12 hours	127		
24 hours	136		
48 hours	142		
72 hours	145		
Snyder Hydrograph Parameters			
Zone[2]	12		
Cp[3]	0.30		
Ct[3]	0.95		
L (miles)[4]	2.75		
Lca (miles)[4]	1.70		
tp = Ct(LxLca) 0.3 hrs.	1.51		
Spillway Data			
Crest Length (ft)	118.5'		
Freeboard (ft)	2.40'		
Discharge Coefficient	C'=0.95		
Exponent	N/A		

(1) Hydrometeorological Report 40 (Figure 1), U.S. Army Corps of Engineers, 1965.

(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).

(3) Snyder's Coefficients.

(4) L=Length of longest water course from outlet to basin divide. L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: D.A.-2.64 mi^2 areas, moderate to steep slopes)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 19 ac-ft

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 28 ac-ft

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 566.1'

SPILLWAY CREST:

a. Elevation — Emergency spillway crest - 563.7'
b. Type — Trapezoidal with concrete weir
c. Width — Bottom - 118.5'
d. Length — Unknown
e. Location Spillover — Left abutment
f. Number and Type of Gates — None

OUTLET WORKS:

a. Type — None
b. Location — None
c. Entrance inverts — None
d. Exit inverts — None
e. Emergency draindown facilities — None

HYDROMETEOROLOGICAL GAUGES:

a. Type — None
b. Location — None
c. Records — None

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

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EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER
SHEET NO. ____ OF ____
BY JAG DATE 4-24-80

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY THE CORPS OF ENGINEERS, BALTIMORE DISTRICT

STRTL = 1 INCH

CNSTL = 0.05 IN/HR

STRTQ = 1.5 CFS/MI²

QRCSN = 0.05 (5% OF PEAK FLOW)

RTIOR = 2.0

ELEVATION - STORAGE CAPACITY RELATIONSHIPS

FROM USGS 7.5 MINUTE QUADRANGLE, AND FIELD INSPECTION DATA

ELEV.	AREA (AC)	AVERAGE AREA (AC)	DEL (FT)	Δ STORAGE (AC-FT)	Σ STORAGE
554*	0				0
		1.52	6	9.1	
560	3.03				9.1
		5.60	20	112.0	
580	8.17				121.1
		13.82	20	276.4	
600	19.47				397.5
		26.17	20	523.4	
620	32.87				920.9
		44.58	20	891.6	
640	56.29				1812.5

* ELEVATION OF "ZERO" AREA EXTRAPOLATED FROM PHOTOGRAPHS

(SEE CHART NEXT PAGE)

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EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER
SHEET NO. ____ OF ____
BY JAG DATE 4-24-80

ELEVATION - STORAGE RELATIONSHIP

# S	0	9.1	27.5	43.5	61.2	88.0	121.1	STORAGE
# E	554	560	564	568	572	576	580	ELEV

TOP OF DAM, EL = 586.1
STORAGE ≈ 33 AC FT

EMERGENCY SPILLWAY CREST, EL 583.7
STORAGE ≈ 24 AC-FT

ELEVATION

640
620
600
580
560
540

0
500
1000

STORAGE, ACFT

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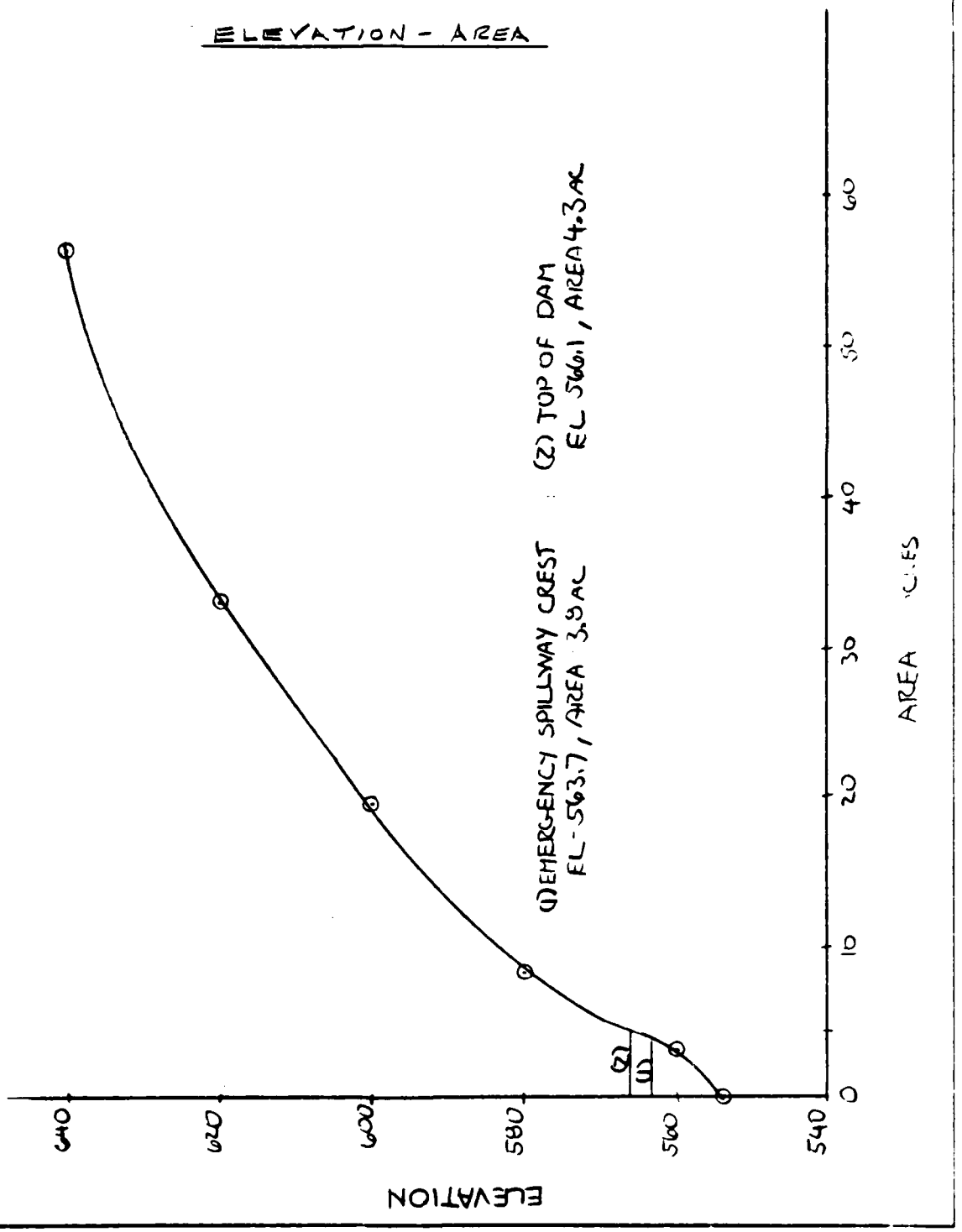
EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER
SHEET NO. ____ OF ____
BY JAC DATE 4-25-80

ELEVATION - AREA



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EBENSBURG PENNSYLVANIA

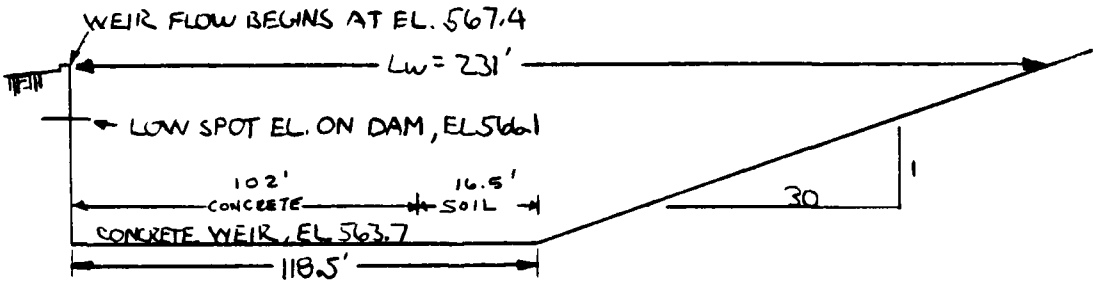
DAM NAME BROWN CREEK DAM
I.D. NUMBER
SHEET NO. ____ OF ____
BY JAG DATE 4-25-80

OVERTOP PARAMETERS

TOP OF DAM ELEVATION (LOW SPOT) - 566.1
LENGTH OF DAM (EXCLUDING SPILLWAY) - 920'
COEFFICIENT OF DISCHARGE - 3.0

$ L	25'	87.5'	567'	860'	930'	1070'	1342'	LENGTH
B V	566.1	566.5	567	567.5	568	570	580	ELEV

DISCHARGE RATING CURVE



LOOKING
EMERGENCY SPILLWAY TYPICAL
(NOT TO SCALE)

TRAPEZOIDAL FLOW FROM:

$$Q = 8.03 C h_v^{1/2} (h_p - h_v)\left[B + Z(h_p - h_v)\right]$$

$$h_v = \frac{3(2Zh_p + B) - \left(16Z^2h_p^2 + 16ZBh_p + 9B^2\right)^{1/2}}{10Z}$$

$B = 118.5'$ $Z = 15$ $C = 0.95$

WEIR FLOW FROM:

$$Q = C L_w H^{1.5}$$

$C = 3.1$ $L_w = 231'$

(SEE CHART NEXT PAGE)

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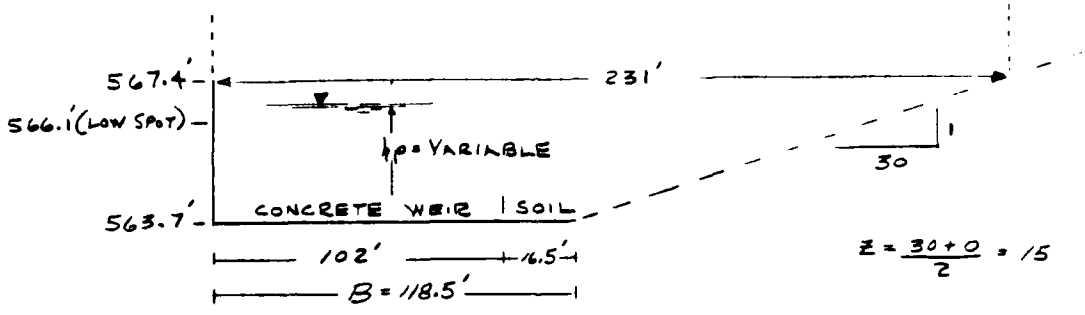
EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER PA-573
SHEET NO. ____ OF ____
BY OTM DATE 5-28-80

OVERTOP PARAMETERS

TOP OF DAM ELEVATION (LOW SPOT) = 566.1'
LENGTH OF DAM (EXCLUDING SPILLWAY) = 920.0'
COEFFICIENT OF DISCHARGE (C) = 3.0
#LMAX. = 1342'
#YMAX. = 580'

DISCHARGE RATING CURVE



EMERGENCY SPILLWAY PROFILE
LOOKING UPSTREAM
NO SCALE

(TRAPEZOIDAL)
FROM $(Q) = 8.03\, C'\, h_v^{1/2}\, (h_p - h_v)\, [B + Z(h_p - h_v)]$

WHERE $(h_v) = \dfrac{3(2Z h_p + B) - (16Z^2 h_p^2 + 16ZBh_p + 9B^2)^{1/2}}{10Z}$

WHERE: $C' = 0.95$ (ENTRANCE LOSS COEFFICIENT).
Z = AVERAGE SIDE SLOPE.
B = BOTTOM WIDTH OF CHANNEL.

(WEIR)
FROM $(Q) = CLH^{3/2}$

	EMERGENCY S.W.	PRINCIPAL S.W.
WHERE:	$C = 3.1$	$C = 3.6$ (OGEE)
	$L = 231'$	$L = 53'$
	H = VARIABLE	H = VARIABLE

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EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER PA. 573
SHEET NO. ____ OF ____
BY OTM DATE 5-28-80

TRAPEZOIDAL FLOW FORMULA;

FROM: WATER AND WASTEWATER ENGINEERING
BY; FAIR, GEYER & OKUM, 1966
(11-14) & (11-15)

LOW DAMS
BY; NATIONAL RESOURCE COMMITTEE
WASHINGTON, D.C., 1938
EQ. (7) & (8)

ELEV. (FT)	PRINCIPAL S.W. WEIR FLOW h (FT)	PRINCIPAL S.W. WEIR FLOW Q (cfs)	PRINCIPAL S.W. FULL PIPE h (FT)	PRINCIPAL S.W. FULL PIPE Q (cfs)	EMERGENCY S.W. TRAPEZOIDAL FLOW hp (FT)	EMERGENCY S.W. TRAPEZOIDAL FLOW Q (cfs)	EMERGENCY S.W. WEIR FLOW h (FT)	EMERGENCY S.W. WEIR FLOW Q (cfs)	DISCHARGE *Q (cfs)
560.0	0	0							0
560.5	.5	67							70
561.0	1	191							190
561.5	1.5	351							350
562.0	2	540							540
562.5	2.5	754							750
563.0	3	991							990
563.7	3.7	1358			0	0			1360
564.0	4	1526			.3	59			1590
564.5	4.5	1821	18.9	~~2192~~	.8	266			2090
565.0	5	2133	19.4	~~2221~~	1.3	573			2710
565.5	5.5	~~2641~~	19.9	2249	1.8	971			3220
566.1	6.1	~~2875~~	20.5	2283	2.4	1463			3750
566.5			20.9	2305	2.8	2027			4330
567.0			21.4	2333	3.3	2686			5020
567.4			21.8	2354	3.7	3278	0	0	5630
568.0			22.4	2386		3278	.6	333	6000
568.5			22.9	2413		3278	1.1	826	6520
569.0			23.4	2439		3278	1.6	1449	7170
570.0			24.4	2491		3278	2.6	3002	8770

* Q ROUNDED TO NEAREST 10 cfs.

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CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME BROWN CREEK DAM
I.D. NUMBER PA - 573
SHEET NO. ____ OF ____
BY OTM DATE 5-28-80

PRINCIPAL SPILLWAY FULL FLOW FORMULA; (S.C.S.)

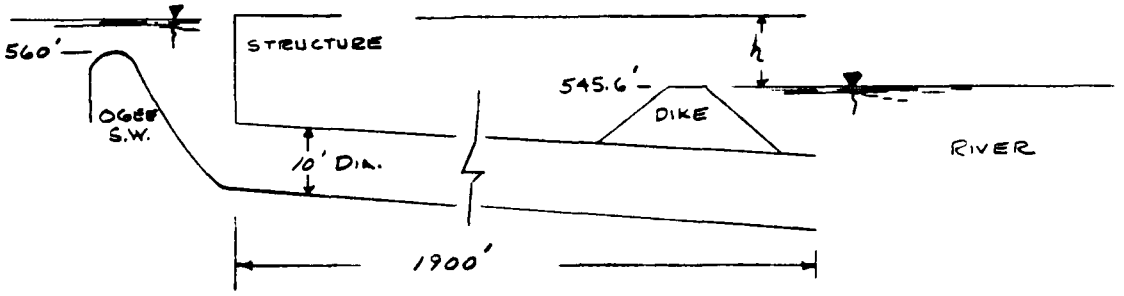
$$Q = CA\sqrt{2gh}$$

WHERE: $C = \frac{1}{\sqrt{\Sigma K}} = \frac{1}{\sqrt{\text{SUM OF LOSSES}}} = 0.80$

A = AREA OF CONDUIT
$= \pi r^2 = \pi (5\ FT)^2$
$= 78.54\ FT^2$

$g = 32.2\ FT/SEC^2$

h = VARIABLE HEAD



SECTION
PRINCIPAL S.W. & CONDUIT
NO SCALE

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF THE SAFETY OF BROWN CREEK DAM
    3                A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (573)
    4                B    288        0       15        0        0        0        0        0        0        0
    5                B1     5
    6                J      1        5        1
    7                J1   .2       .3       .4       .6        1
    8                K      0        1                                      1
    9                K1       INFLOW TO RESERVOIR
   10                N      1        1     2.64                                                    1
   11                P             21.76      117      127      136      142      145
   12                T                                                     1.0      .05
   13                W   1.51       .3
   14                X   -1.5     -.05      2.0
   15                K      1        2                                      1
   16                K1       ROUTE THROUGH RESERVOIR
   17                Y                                 1        1
   18                Y1     1                                             -560       -1
   19                Y4   560    560.5    561.0    561.5    562.0    562.5    563.0    563.7    564.0    564.5
   20                Y4 565.0    565.5    566.1    566.5    567.0    567.4    568.0    568.5    569.0    570.0
   21                Y5     0       70      190      350      540      750      990     1360     1590     2090
   22                Y5  2710     3220     3750     4330     5020     5630     6000     6520     7170     8770
   23                $A     0     3.03     8.17    19.47    32.87    56.29
   24                $E   554      560      580      600      620      640
   25                $$ 563.7
   26                $D 566.1      3.0      1.5      920
   27                $L    25     87.5      567      860      930     1070     1342
   28                $V 566.1    566.5      567    567.5      568      570      580
   29                K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/05/28.
TIME= 07.30.24.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF THE SAFETY OF BROWN CREEK DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (573)

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .20 .30 .40 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.64	0.00	2.64	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.76	117.00	127.00	136.00	142.00	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	[illegible]	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.51 CP= .30 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.11 AND R=16.50 INTERVALS

UNIT HYDROGRAPH 91 END-OF-PERIOD ORDINATES, LAG= 1.52 HOURS, CP= .30 VOL= 1.00

19.	71.	145.	226.	294.	334.	336.	317.	298.	281.
264.	249.	234.	220.	207.	195.	184.	173.	163.	153.
144.	136.	128.	120.	113.	106.	100.	94.	89.	83.
79.	74.	70.	66.	62.	58.	55.	51.	48.	46.
43.	40.	38.	36.	34.	32.	30.	28.	26.	25.
23.	22.	21.	19.	18.	17.	16.	15.	14.	14.
13.	12.	11.	11.	10.	9.	9.	8.	8.	7.
7.	7.	6.	6.	5.	5.	5.	5.	4.	4.
4.	4.	3.	3.	3.	3.	3.	2.	2.	2.
2.									

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	ISK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-560.	-1

STAGE	560.00	560.50	561.00	561.50	562.00	562.50	563.00	563.70	564.00
564.50									
	565.00	565.50	566.10	566.50	567.00	567.40	568.00	568.50	569.00
570.00									
FLOW	0.00	70.00	190.00	350.00	540.00	750.00	990.00	1360.00	1590.00
2090.00									
	2710.00	3220.00	3750.00	4330.00	5020.00	5630.00	6000.00	6520.00	7170.00
8770.00									

SURFACE AREA=	0.	3.	8.	19.	33.	56.
CAPACITY=	0.	6.	114.	382.	900.	1781.
ELEVATION=	554.	560.	580.	600.	620.	640.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
563.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
566.1	3.0	1.5	920.

CREST LENGTH	25.	88.	567.	860.	930.	1070.	1342.
AT OR BELOW ELEVATION	566.1	566.5	567.0	567.5	568.0	570.0	580.0

STATION 2 , PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 1.00
HYDROGRAPH AT	1	2.64	1	946.	1419.	1893.	2366.	4732.
		(6.84)		(26.80)(	40.19)(	53.59)(	66.99)(	133.98)(
ROUTED TO	2	2.64	1	947.	1420.	1894.	2368.	4735.
		(6.84)		(26.82)(	40.20)(	53.64)(	67.06)(	134.09)(

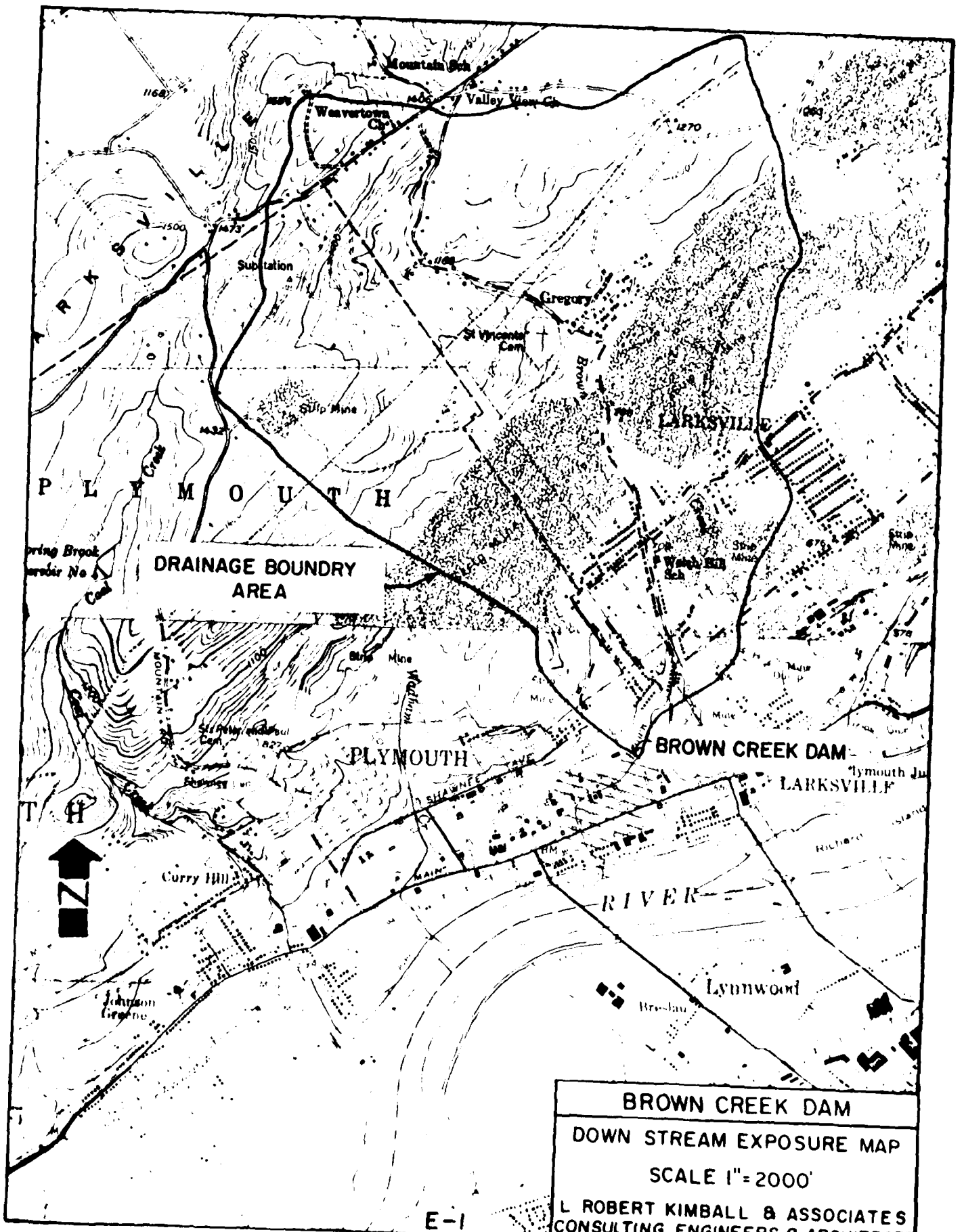
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	560.00	563.70	566.10
STORAGE	6.	19.	28.
OUTFLOW	0.	1360.	3750.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	562.91	0.00	16.	947.	0.00	41.50	0.00
.30	563.78	0.00	19.	1420.	0.00	41.50	0.00
.40	564.30	0.00	21.	1894.	0.00	41.50	0.00
.50	564.72	0.00	23.	2368.	0.00	41.50	0.00
1.00	566.71	.61	31.	4735.	3.25	41.25	0.00

APPENDIX E
DRAWINGS

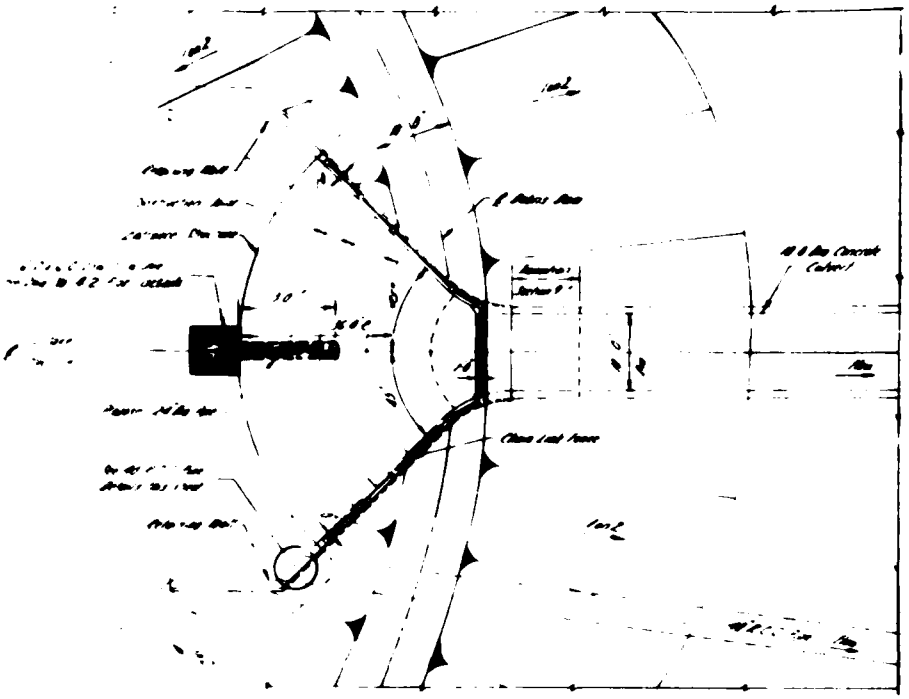


BROWN CREEK DAM

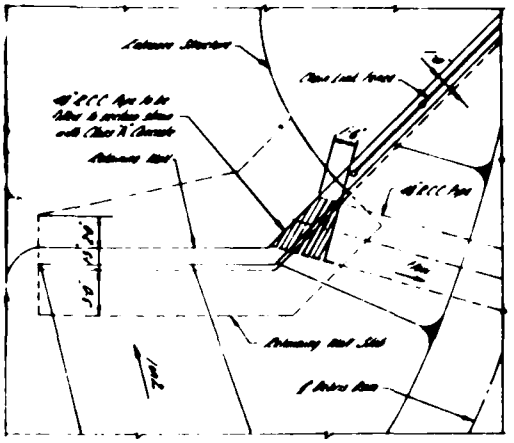
DOWN STREAM EXPOSURE MAP

SCALE 1" = 2000'

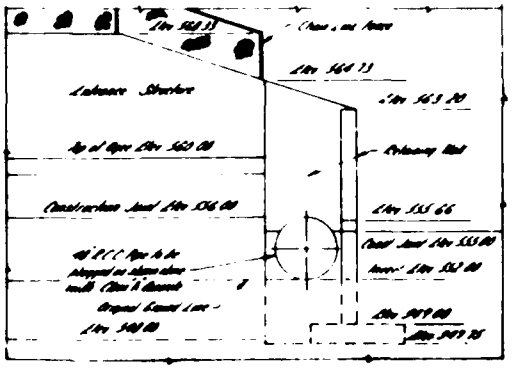
L ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



PLAN

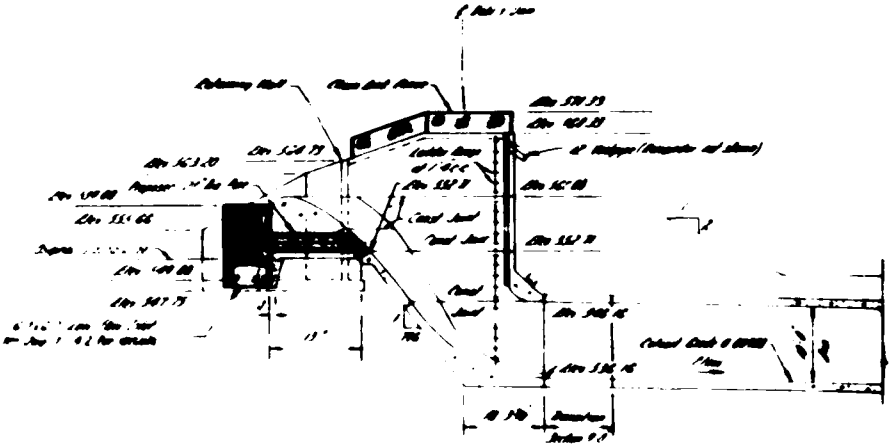


PLAN



ELEVATION

PLUG IN 48" DIAMETER DRAIN PIPE

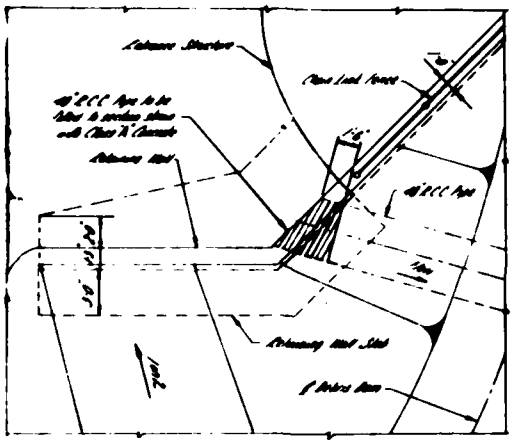


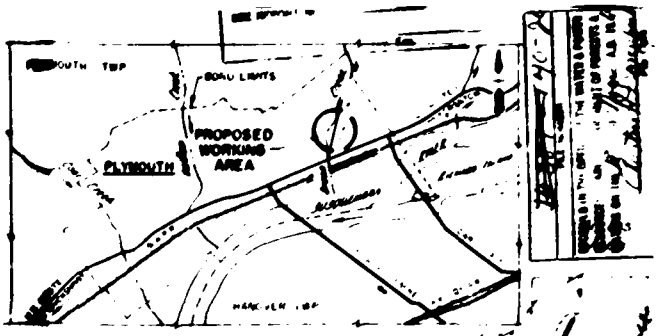
CENTERLINE ELEVATION

NOTES

1 Shadow indicates proposed construction

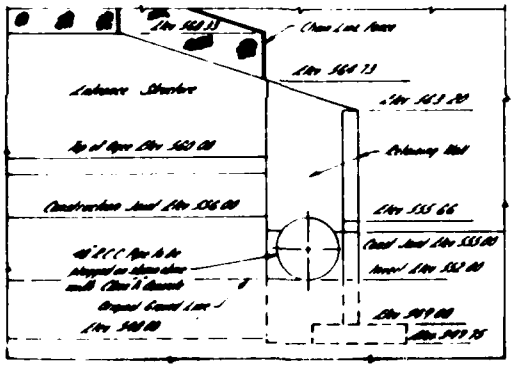
NO	DATE	REVISION





LOCATION MAP

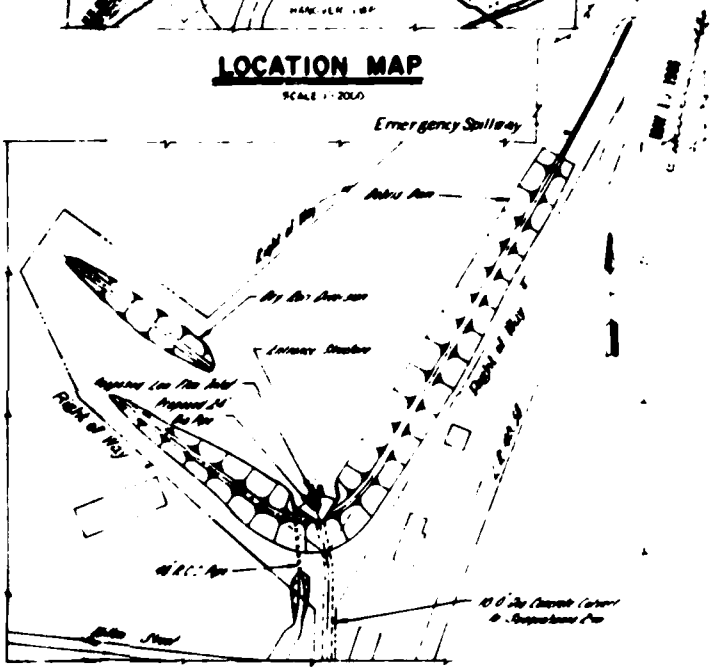
SCALE 1" = 2000'



ELEVATION

PLUG IN 48" DIAMETER DRAIN PIPE

SCALE 1/4" = 1'-0"



GENERAL PLAN

SCALE 1" = 100'

NOTES:

1. Shoulder width as proposed construction.

NO	DATE	REVISION	BY	CHK	APPR

E. H. BOURQUARD & ASSOCIATES

CONSULTING HYDRAULIC ENGINEERS

1822 N SECOND STREET HARRISBURG, PA

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF FORESTS & WATERS

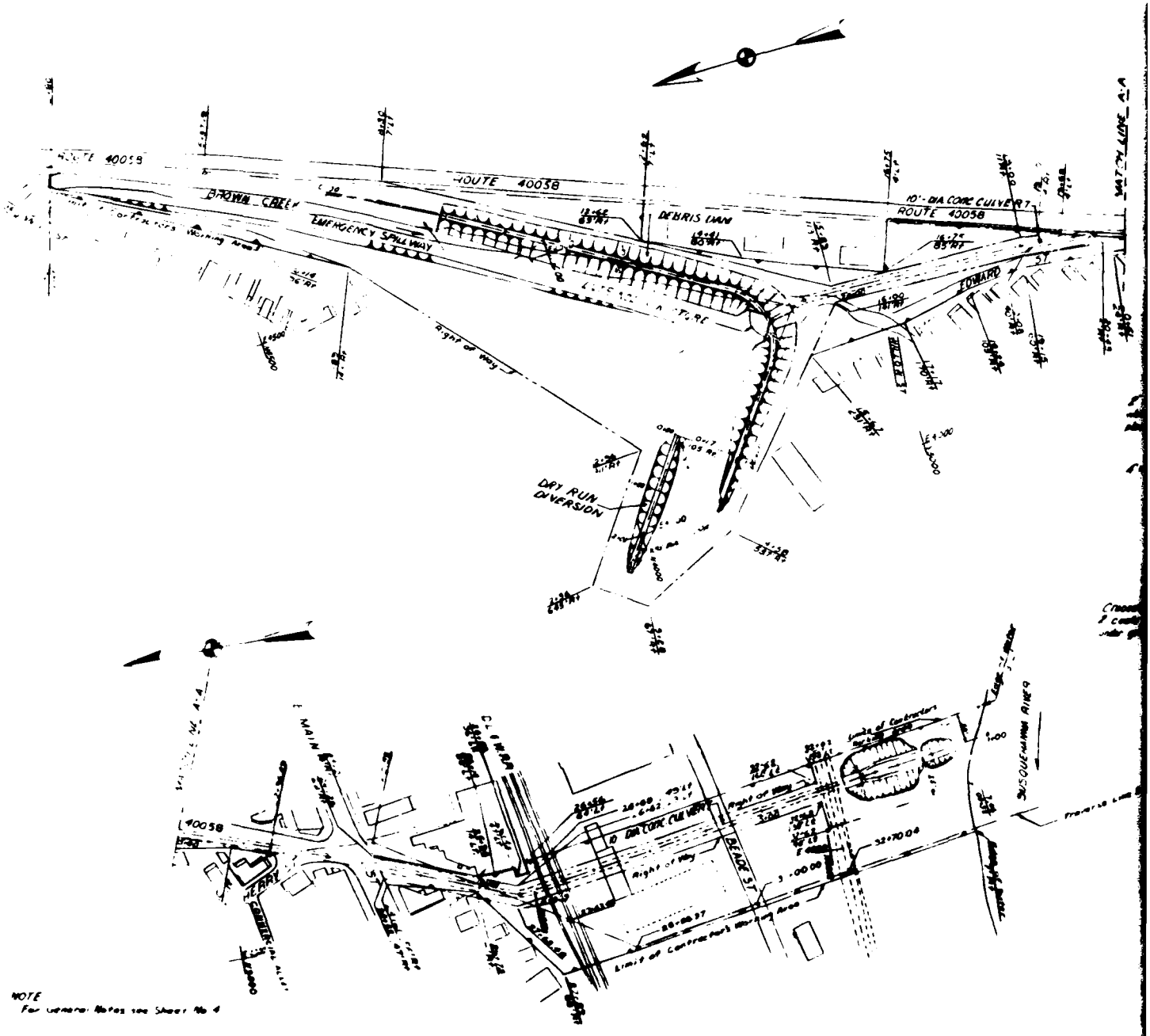
DIVISION OF FLOOD CONTROL

LOCATION MAP-GENERAL PLANS & ELEVATIONS

MODIFICATIONS TO
BROWN CREEK
FLOOD PROTECTION PROJECT
PLYMOUTH PENNSYLVANIA
LUZERNE COUNTY

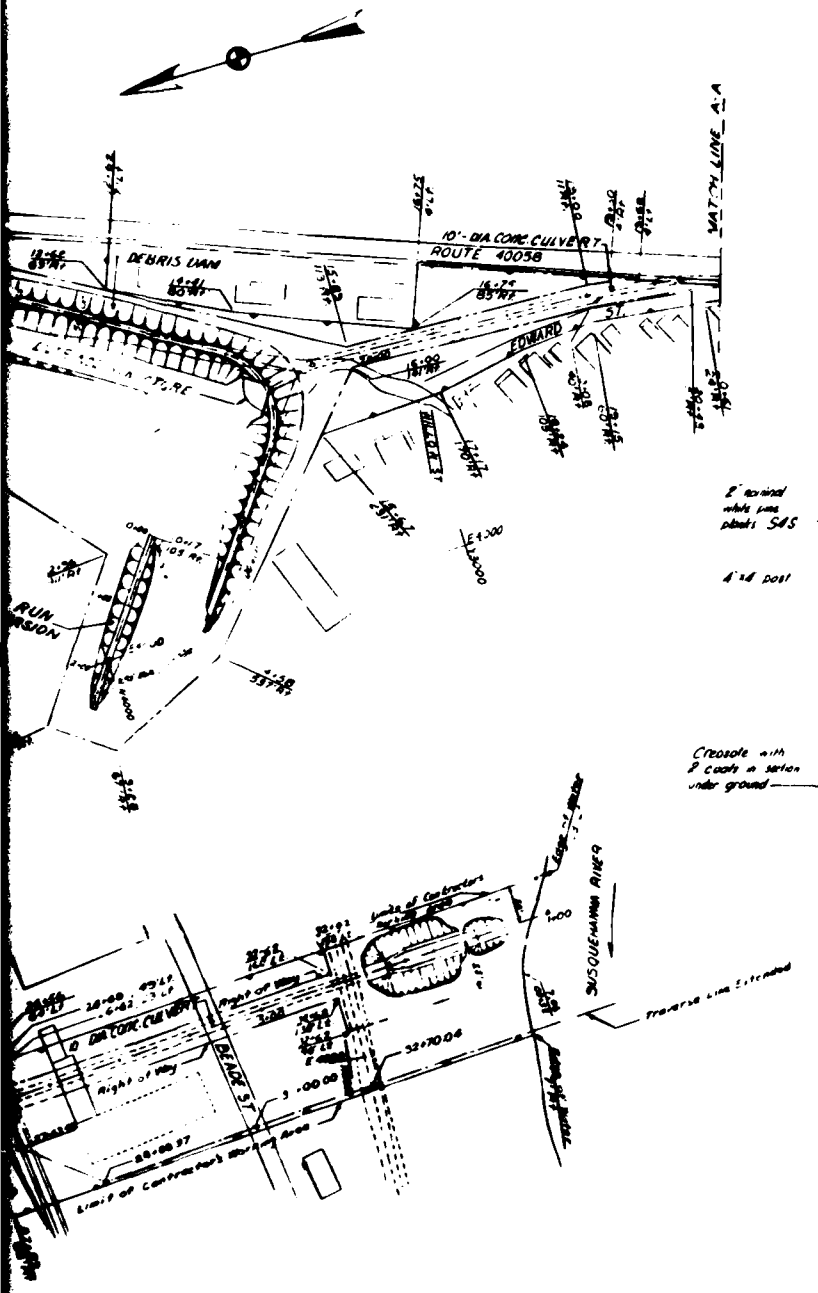
DESIGNED	EHB	SUBM	CHIEF FLOOD CONTROL DIV DATE
DRAWN	WBD		
TRACED	WBD	RECOM	CHIEF ENGINEER
CHECKED	JJB	APPR	SECRETARY

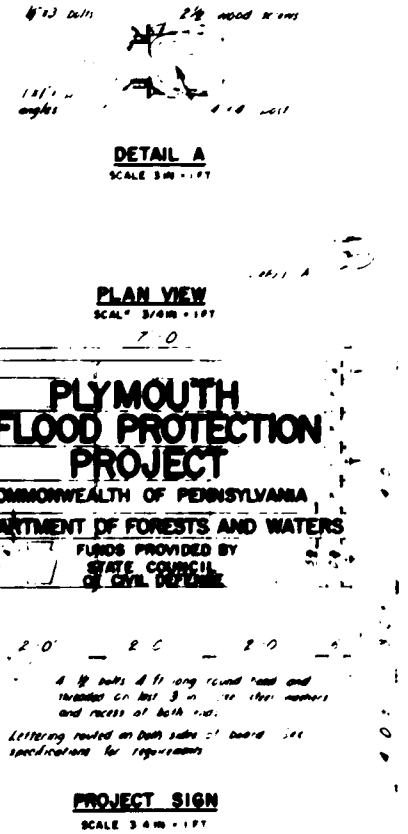
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



NOTE
For General Notes see Sheet No 4

SCALE: 1IN.=100FT.





PLYMOUTH FLOOD PROTECTION PROJECT

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
FUNDS PROVIDED BY STATE COUNCIL OF CIVIL DEFENSE

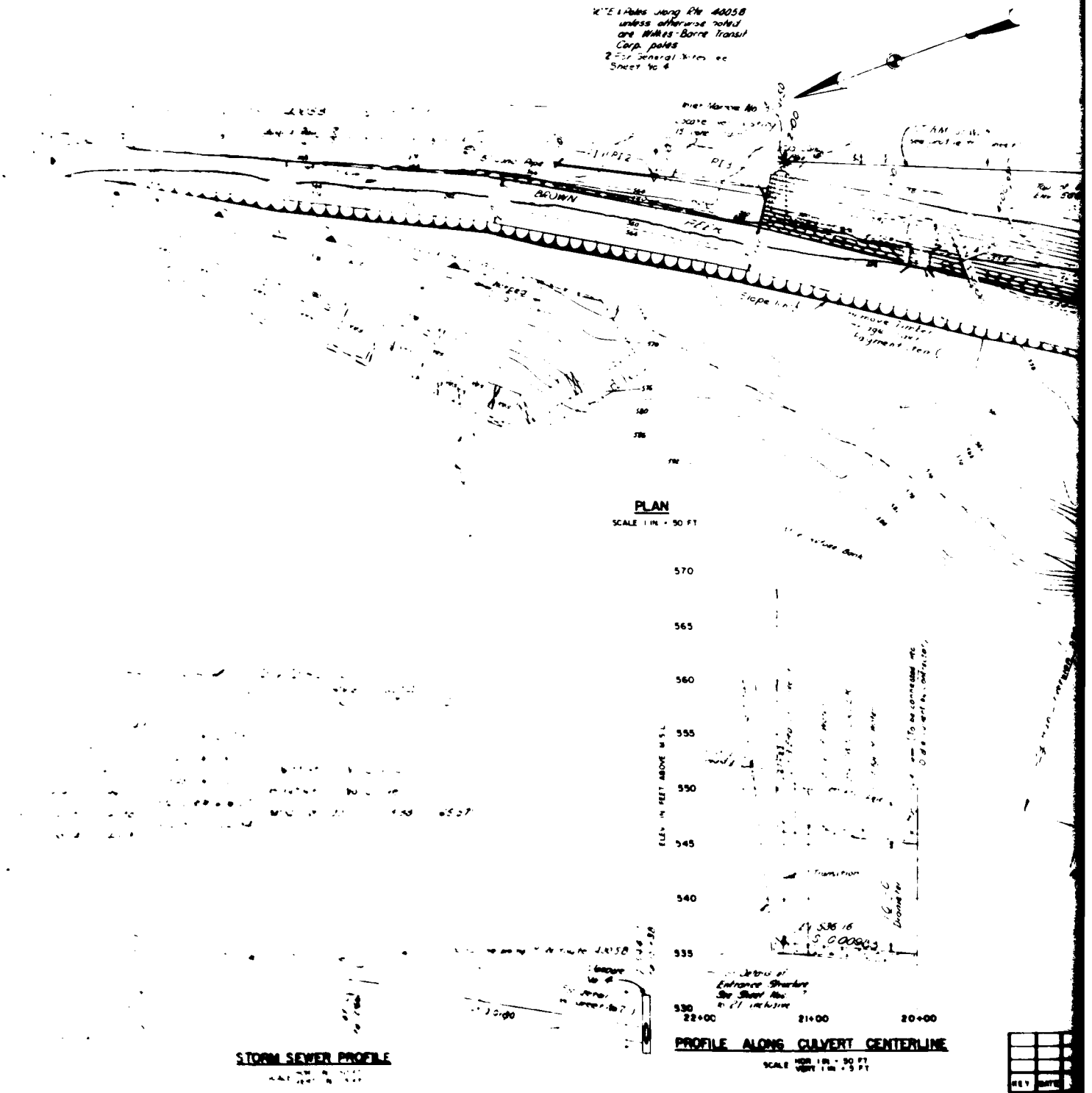
BOURQUARD, GEIL & ASSOCIATES
CONSULTING HYDRAULIC ENGINEERS HARRISBURG, PA.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF FLOOD CONTROL

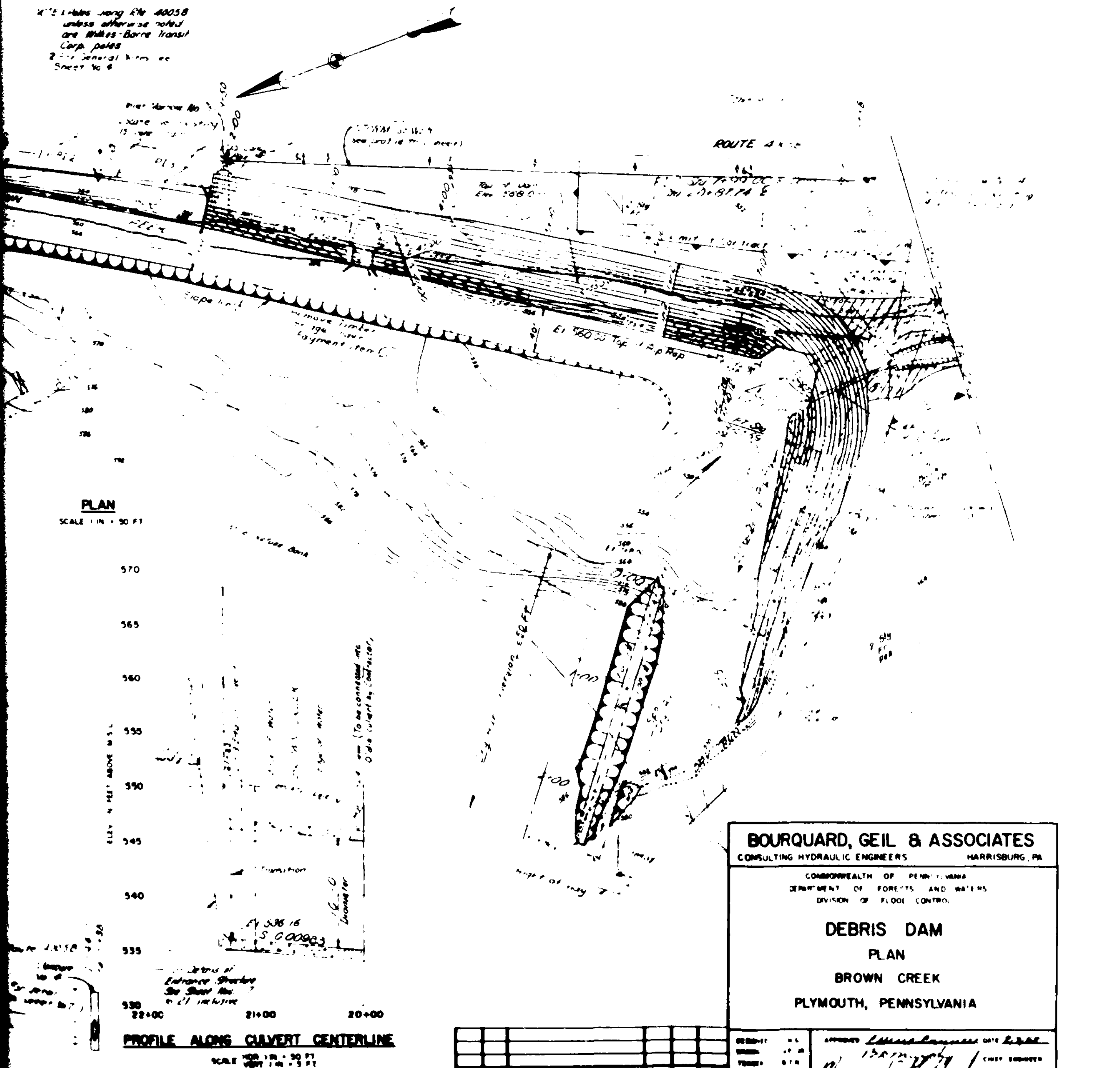
GENERAL PLAN
DEBRIS DAM &
CONCRETE CULVERT
BROWN CREEK
PLYMOUTH, PENNSYLVANIA

REV	DATE	REVISION	REV	CHK	APPR

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



STORM SEWER PROFILE



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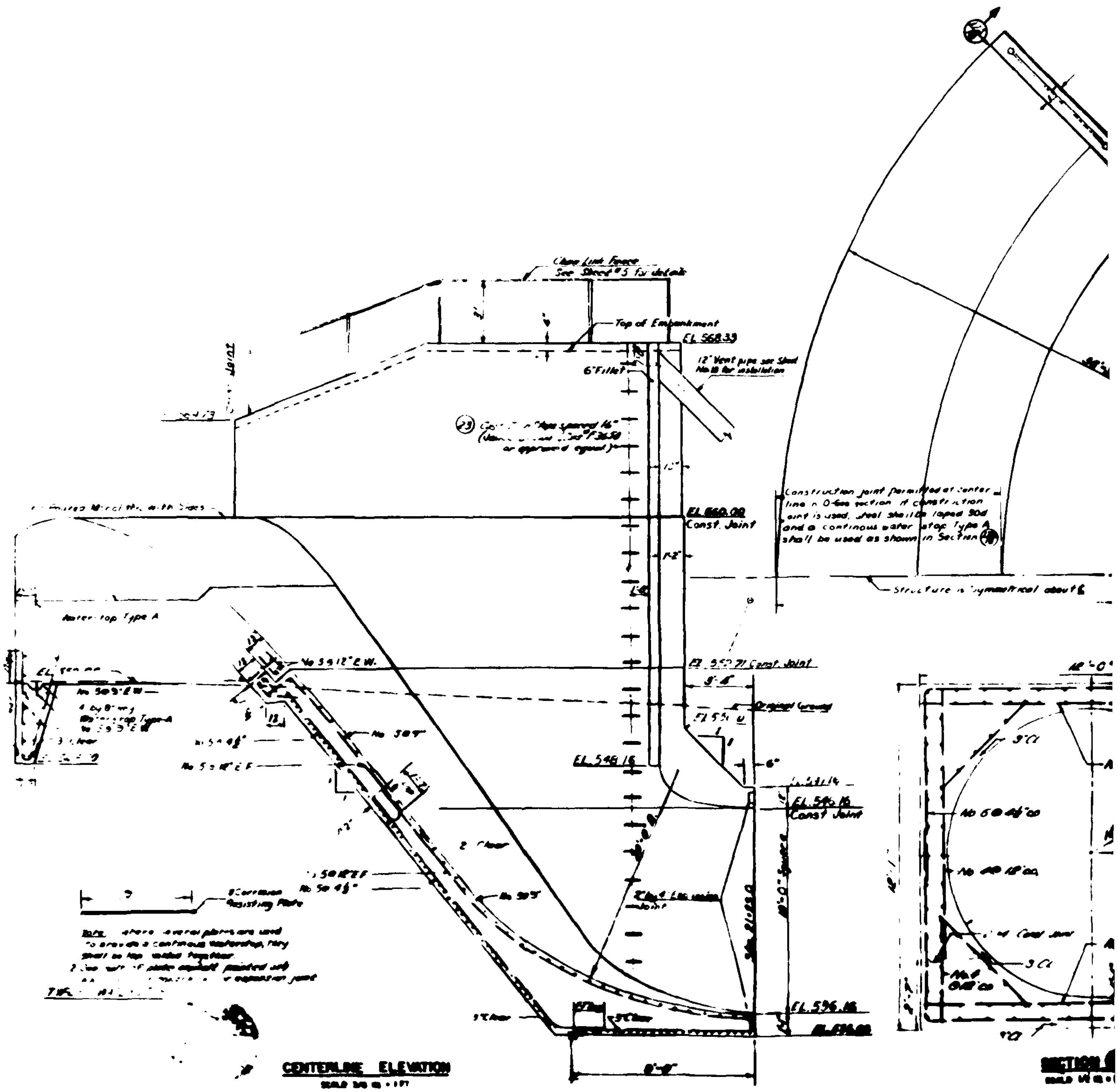
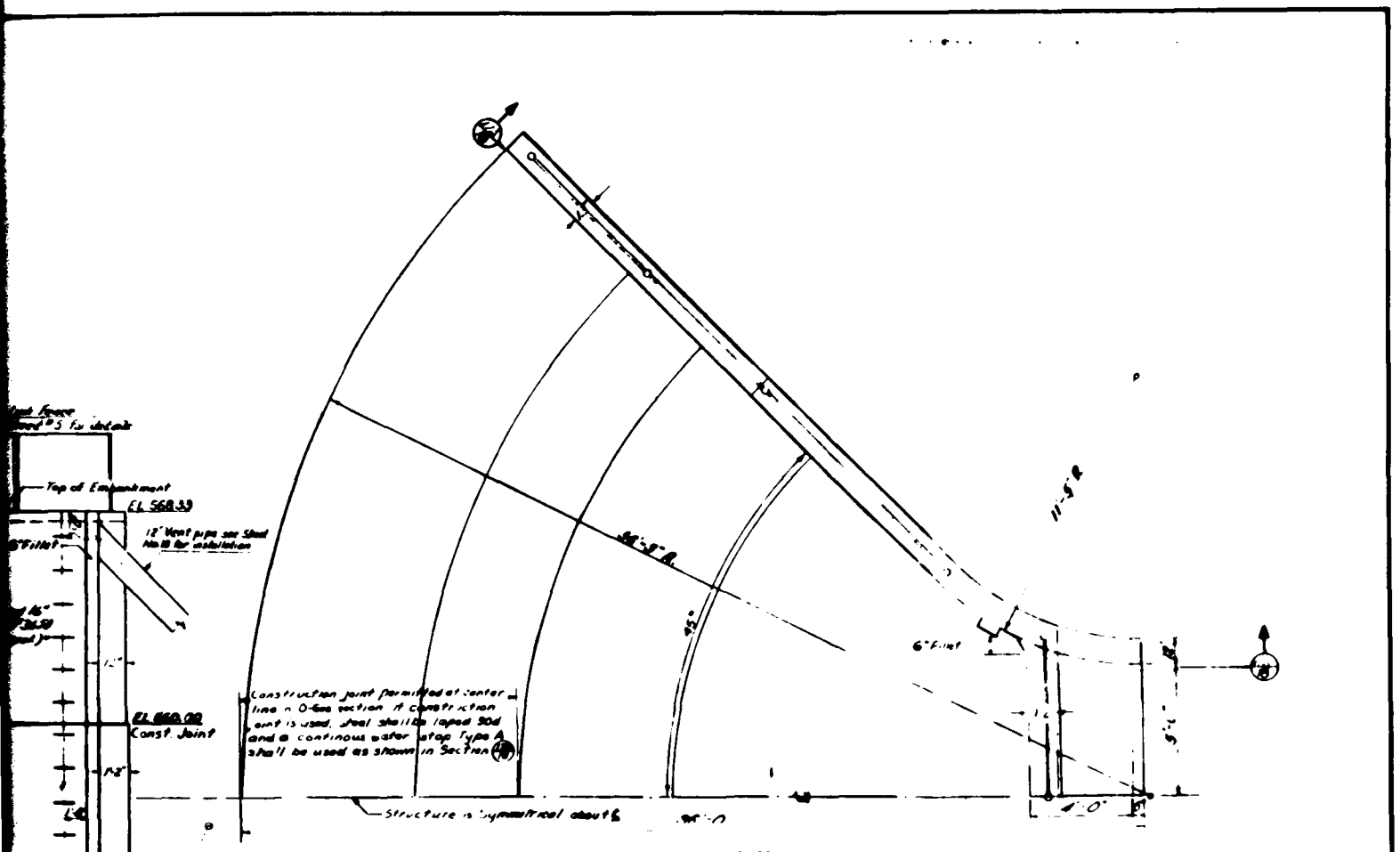
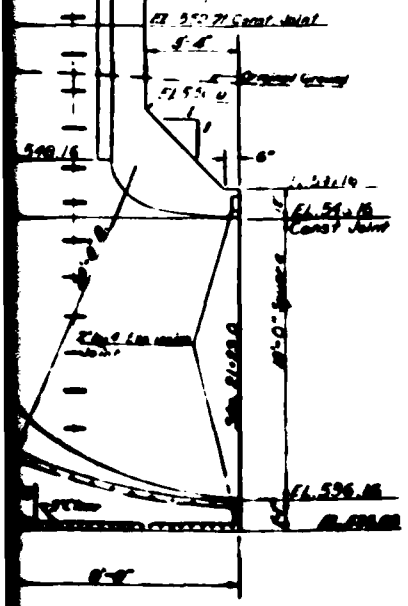
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF FLOOD CONTROL

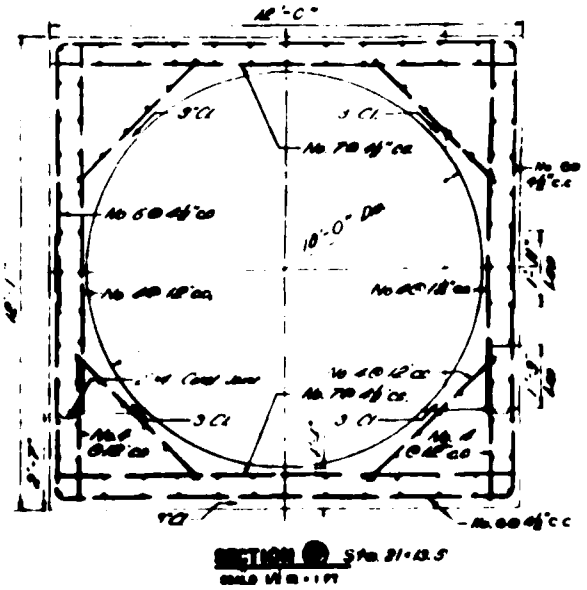
DEBRIS DAM
PLAN
BROWN CREEK
PLYMOUTH, PENNSYLVANIA

KEY	DATE	REVISION	REV	CHK	APPR


Chain Link Fence
See Sheet #5 for details
Top of Embankment
EL 568.33
12" Vent pipe see Sheet No.18 for installation
6" Fillet
EL 560.00
Const. Joint
Construction joint permitted at center line in O-Gee section. If construction joint is used, steel shall be lapped 30d and a continous water stop Type A shall be used as shown in Section
Structure is symmetrical about ℄
Water stop Type A
No 5 @ 12" E.W.
Original Ground
EL 546.16
EL 596.16
Const Joint
No 5 @ 9"
2" Clear
No 6 @ 4½" oc
3" Cl
3" Clear
3" Cl
CENTERLINE ELEVATION







NOTES

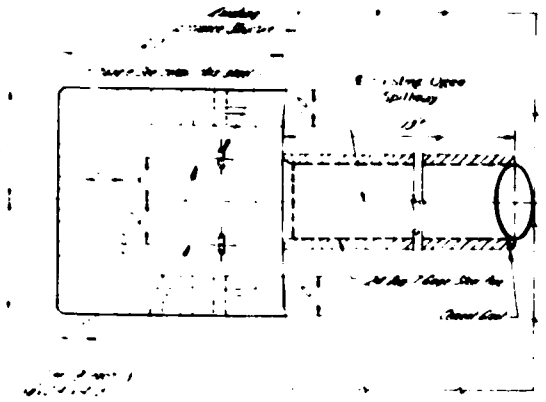
REV	DATE	REVISIONS	REV	CHK	APPR

BOURGUARD, GEIL & ASSOCIATES
CONSULTING HYDRAULIC ENGINEERS HARRISBURG, PA.

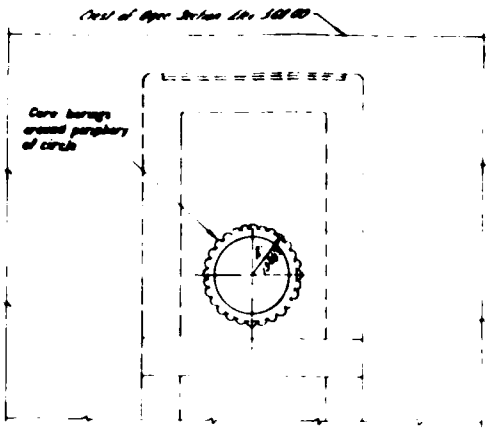
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF FLOOD CONTROL

ENTRANCE STRUCTURE
PLAN & ELEVATION
BROWN CREEK
PLYMOUTH, PENNSYLVANIA

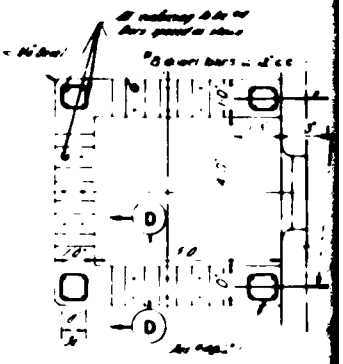
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



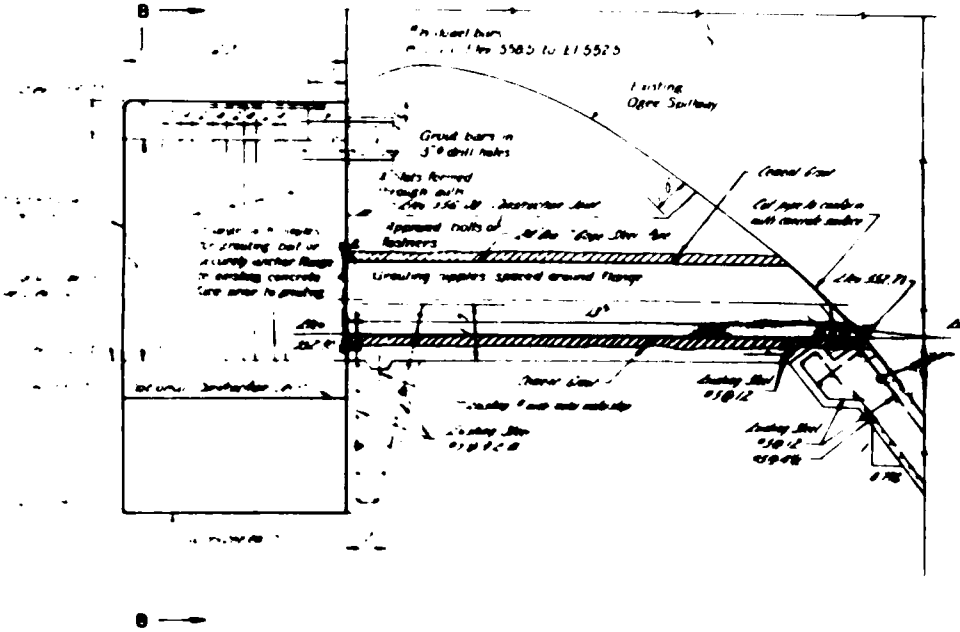
PLAN



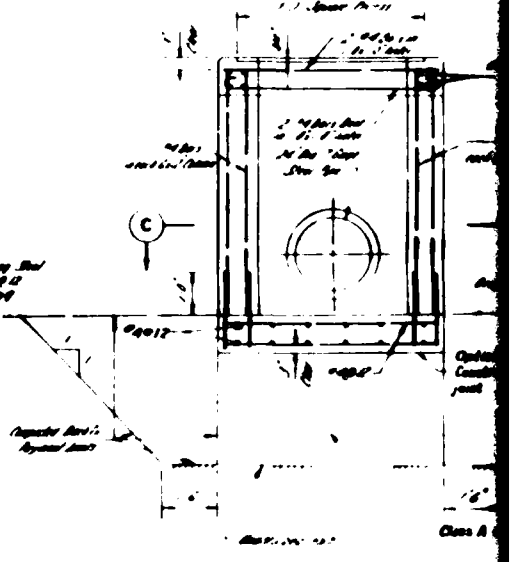
RIGHT ELEVATION



SECTION C-C



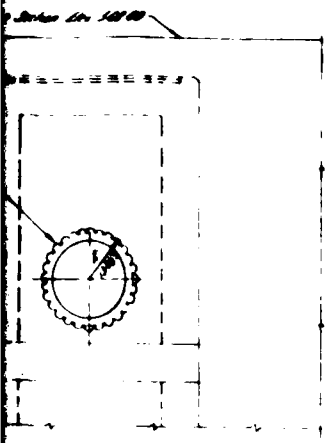
CENTERLINE ELEVATION



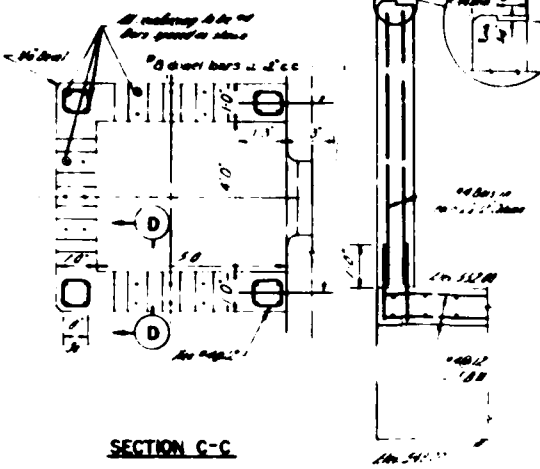
SECTION B-B

LOW FLOW INLET DETAILS

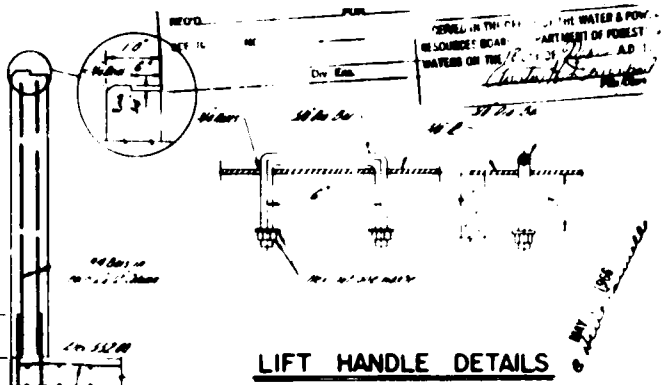
SCALE 1/2"



RIGHT ELEVATION



SECTION C-C



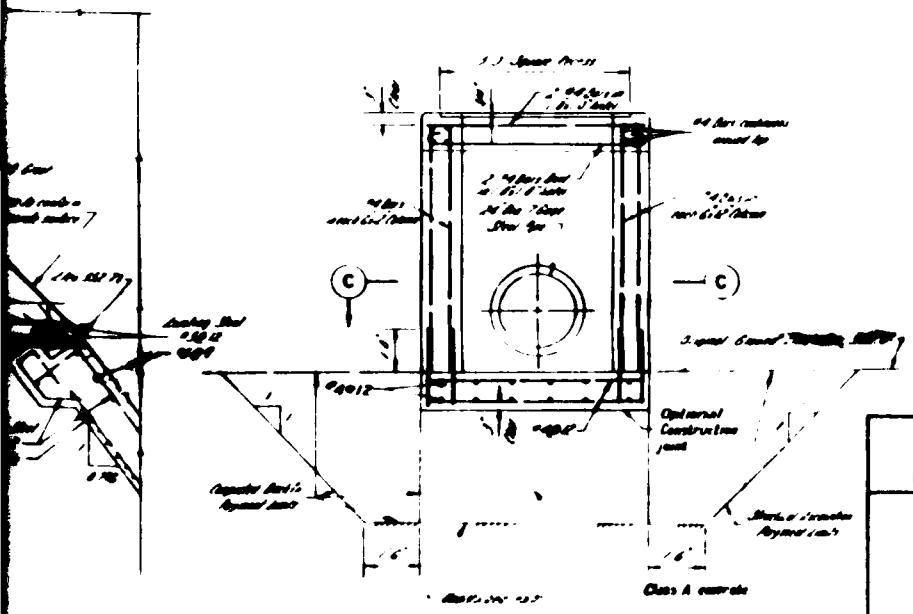
LIFT HANDLE DETAILS

SCALE

Notes:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. Steel cover plates and lift handles to be galvanized after fabrication.

SECTION D-D



SECTION B-B

INLET DETAILS

SCALE

E. H. BOURQUARD & ASSOCIATES
CONSULTING HYDRAULIC ENGINEERS
1822 N SECOND STREET HARRISBURG PA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS & WATERS
DIVISION OF FLOOD CONTROL

LOW FLOW INLET DETAILS

MODIFICATIONS TO
BROWN CREEK
FLOOD PROTECTION PROJECT
PLYMOUTH PENNSYLVANIA
LUZERNE COUNTY

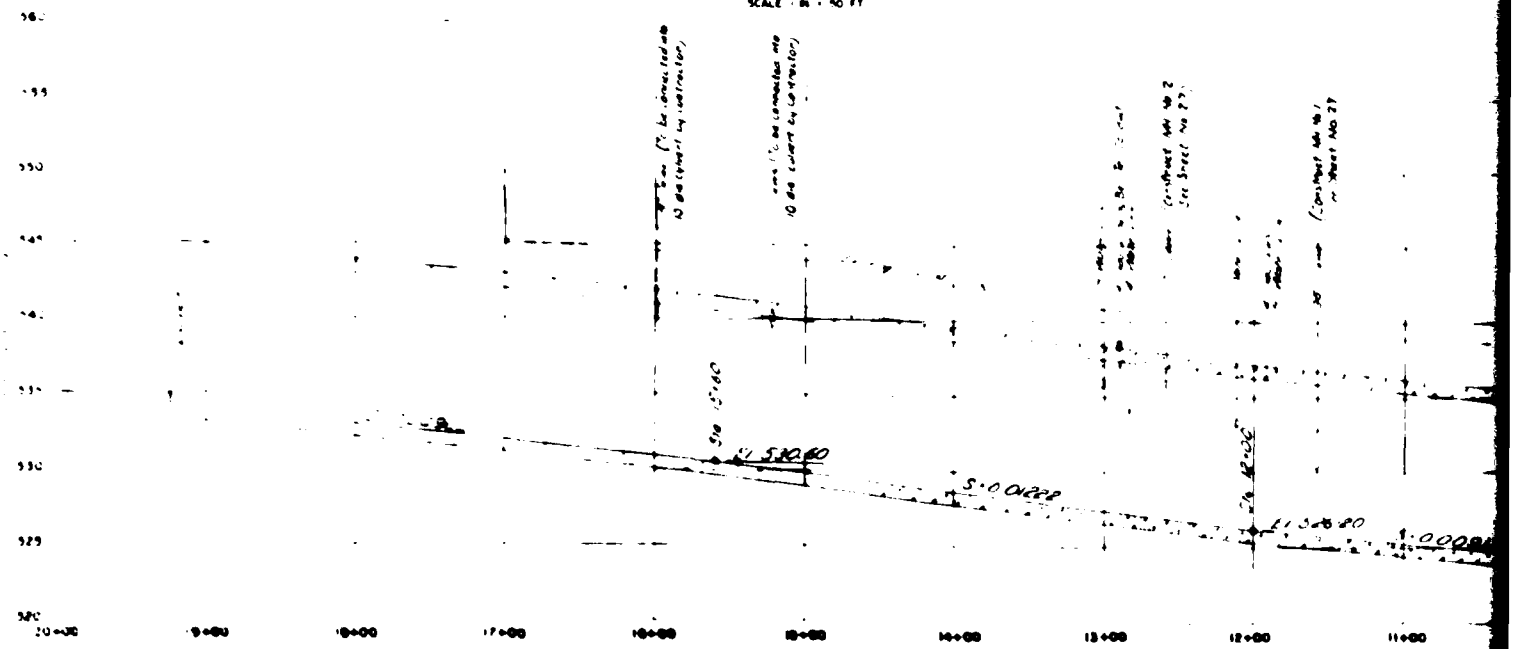
DESIGNED	EHB	SUBM	CHIEF, DIV. OF FLOOD CONTROL DIV.
DRAWN	WBD	RECOM	CHIEF ENGINEER
TRACED	WBD	APPR	SECRETARY
CHECKED	[illegible]		

NO.	DATE	REVISION	DEV	CHK	APPR

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

PLAN

SCALE : IN = 50 FT

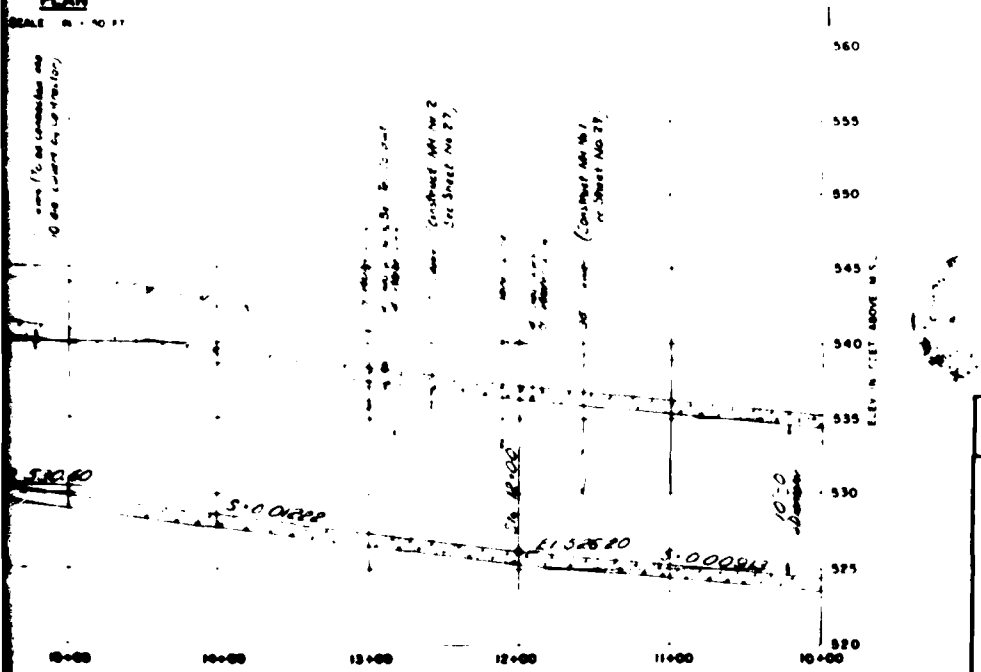


PROFILE ALONG CULVERT CENTERLINE

SCALE HOR. : IN = 50 FT.
VERT. : IN = 5 FT

NO.	DATE	REVISION

PLAN



CULVERT CENTERLINE

BOURQUARD, GEIL & ASSOCIATES
CONSULTING HYDRAULIC ENGINEERS HARRISBURG, PA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF FLOOD CONTROL

CONCRETE CULVERT

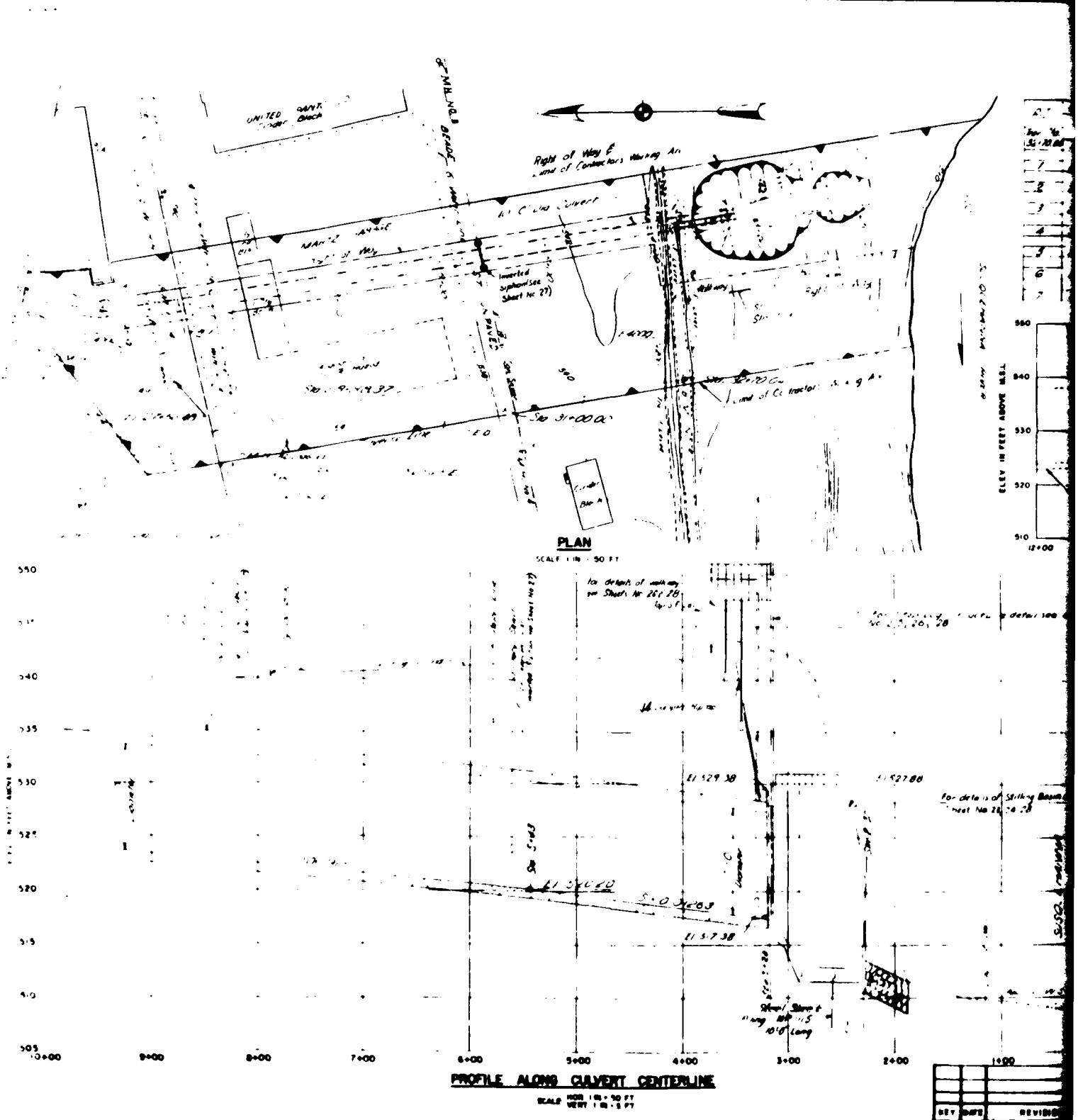
PLAN & PROFILE

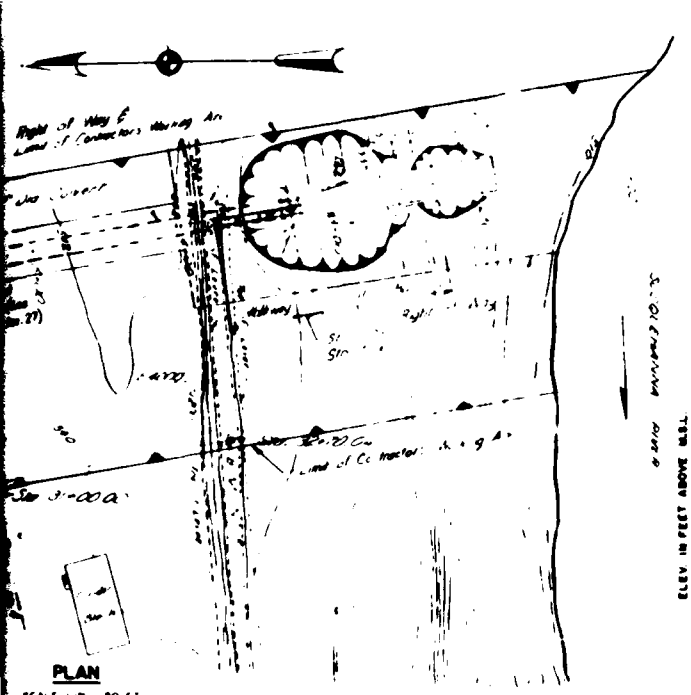
BROWN CREEK

PLYMOUTH, PENNSYLVANIA

REV	DATE	REVISION	REV	CHK	APPD

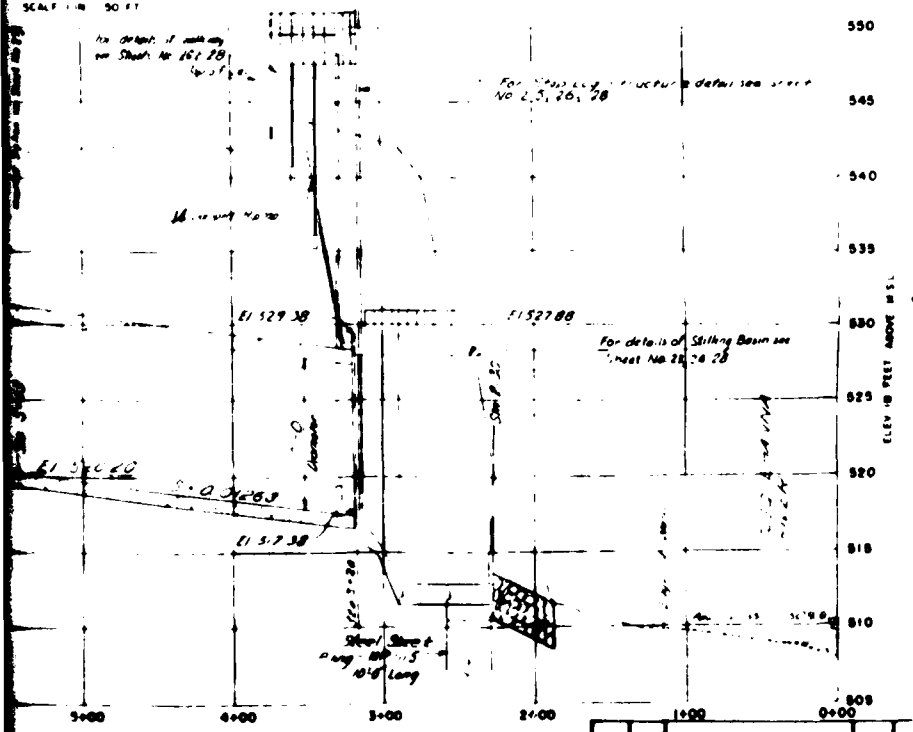
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS


PLAN
SCALE 1 IN = 50 FT
PROFILE ALONG CULVERT CENTERLINE
10+00
9+00
8+00
7+00
6+00
5+00
4+00
3+00
2+00
1+00



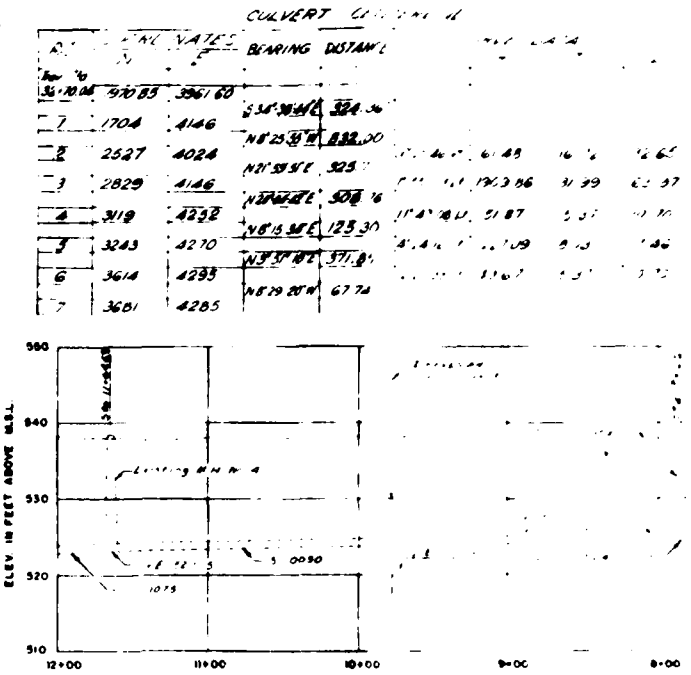
PLAN

SCALE 1 IN = 50 FT



CULVERT CENTERLINE

SCALE HOR. 1 IN = 50 FT
VERT. 1 IN = 5 FT



PROFILE ALONG CENTERLINE
EXISTING 10"VC SAN. SEWER
AT CULVERT STA. 5+61±

SCALE HOR. 1 IN = 50 FT
VERT. 1 IN = 5 FT

NOTE
For General
see Sheet No. 4

TRENCH EXCAVATION

BOURQUARD, GEIL & ASSOCIATES
CONSULTING HYDRAULIC ENGINEERS HARRISBURG, PA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF FLOOD CONTROL

CONCRETE CULVERT
PLAN & PROFILE
BROWN CREEK
PLYMOUTH, PENNSYLVANIA

REV	DATE	REVISION	REV	CHK	APPR

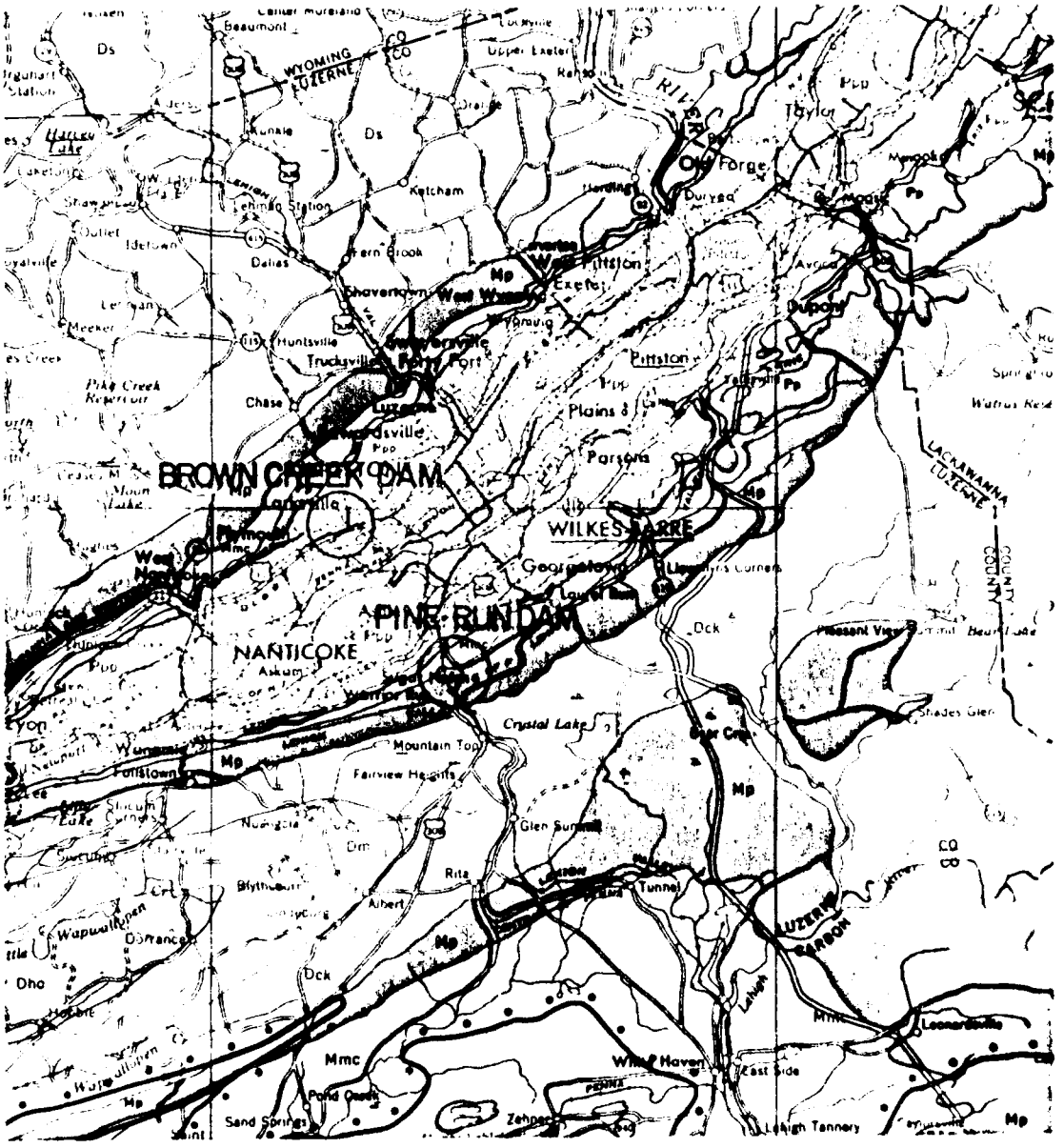
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

APPENDIX F
GEOLOGY

General Geology

Brown Creek Debris Dam lies within the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. This area is characterized by overturned and assymetric folds, local shearing and large, low-angle thrust faults. There is some minor faulting indicated a few miles to the west of the dam.

The bedrock underlying Brown Creek Debris Dam consists of the Pennsylvanian aged Post-Pottsville Formations. These rocks are primarily light colored and interbedded sandstone and conglomerate, coal, and dark shale. The usually thin beds are moderately well developed. The blocky, moderate spaced and abundant joints are open and steeply dipping. The formations are fairly resistant to weathering and provide a good foundation for heavy structures when excavated to sound material if no underground coal mining has occurred.



GEOLOGICAL MAP OF THE AREA AROUND PINE RUN DAM AND BROWN CREEK DAM

ANTHRACITE REGION

Post Pottsville Formations

Mp — Pocono Group

SCALE 1: 250,000